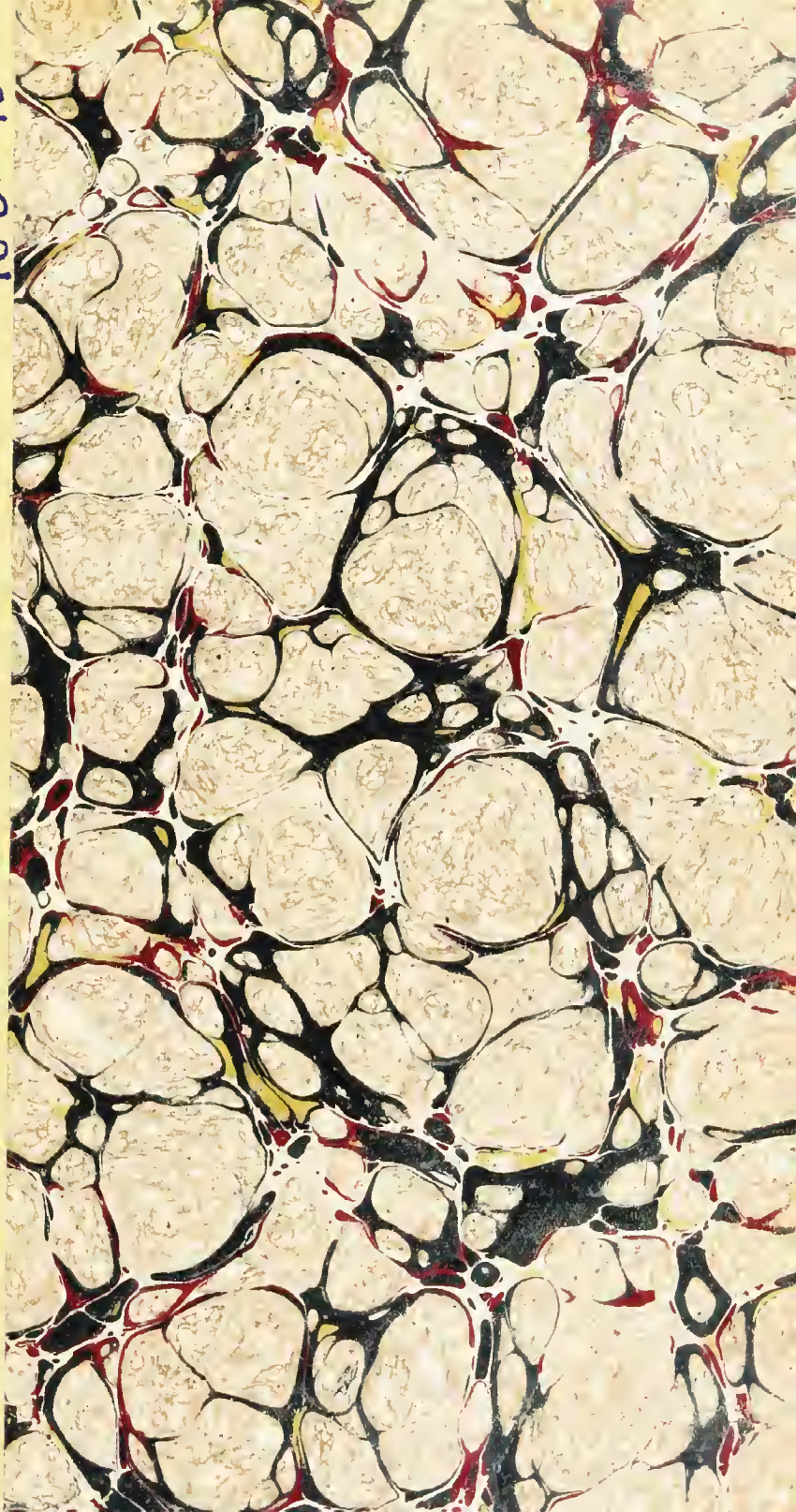


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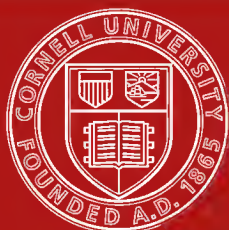
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MEMOIRS OF THE GEOLOGICAL SURVEY.
ENGLAND AND WALES.

THE GEOLOGY OF
THE COUNTRY AROUND
SOUTHAMPTON.

(EXPLANATION OF SHEET 315.)

BY
CLEMENT REID, F.R.S., F.L.S., F.G.S.,
WITH CONTRIBUTIONS BY W. WHITAKER, F.R.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HIS MAJESTY'S TREASURY.



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ENGLAND AND WALES.

THE GEOLOGY OF
THE COUNTRY AROUND
SOUTHAMPTON.

(EXPLANATION OF SHEET 315.)

BY

CLEMENT REID, F.R.S., F.L.S., F.G.S.,

WITH CONTRIBUTIONS BY W. WHITAKER, F.R.S.

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P R E F A C E .

THE district around Southampton was originally surveyed by Mr. Bristow, and the results published in Sheets 11 and 15 of the Old Series of Maps in the years 1856 and 1858. No Memoirs were written in explanation of these sheets.

The re-survey on the six-inch scale has been carried out by Mr. Whitaker and Mr. Reid. The solid geology has been revised, and the distribution of the older drift deposits, which were ignored in the earlier maps, but which exercise an important influence on the topography of the district, on the soils, and on the distribution of the minor settlements, has been recorded. The results of this work have been reduced and published on the one-inch scale [Sheet 315], but the six-inch maps have been deposited in the Office, and are available to the public for reference. Copies of these maps may be obtained on payment of the cost of making them. The most important result so far as the older rocks are concerned is the recognition of several inliers of London Clay, which are so situated as to indicate an extension to the westward of the Portsdown anticline.

The principal work in the preparation of the Memoir has fallen to Mr. Reid, but Mr. Whitaker has contributed those portions which relate to the areas he has mapped around Southampton and Eastleigh.

Professor Prestwich, the Rev. O. Fisher, Mr. T. W. Shore, and Mr. Elwes are the principal writers to whom we are indebted but the valuable collection of fossils made by Mr. F. E. Edwards, Mr. Keeping and Captain Hicks-Beach have also been utilised. To the Rev. O. Fisher, Sir John Evans, and Captain Hicks-Beach our special thanks are due.

J. J. H. TEALL,
Director.

June 19th, 1901.

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THE GEOLOGY OF

THE COUNTRY AROUND

SOUTHAMPTON.

CHAPTER I.—INTRODUCTION.

SHEET 315 of the Geological Survey Map takes in an area of 216 square miles, of which about 5 square miles are occupied by water at all states of the tide. The whole of this area, with the exception of a few square miles to the north-west, which belong to Wiltshire, is included in the county of Hampshire; about one-third of it belongs to the New Forest. The towns within the district are Southampton, Romsey, Lyndhurst, Eastleigh, and Botley. The wide tidal estuary and harbour of Southampton Water, with its tributaries the Test, Itchen, and Hamble, forms the most noticeable feature; for the country though undulating is devoid of conspicuous heights. Its highest hills are merely flat-topped isolated table-lands, ending on every side in steep scarps, which have been carved out of once-continuous plains of gravel-capped Tertiary strata. None of the bare Tertiary or Chalk hills reaches a height equal to this gravel plateau, which rises to 415 feet where it is crossed by the road to Fordingbridge.

The formations represented in Sheet 315 are the following :—

Recent	-	{ Peat. Alluvium. Marl.
Pleistocene		{ Brickearth. Valley Gravel. Plateau Gravel. Clay with Flints.
Oligocene	- . . -	Headon Beds.
Eocene	. . .	{ Barton Sands. Barton Clay. Bracklesham Series. Bagshot Sands. London Clay. Reading Beds.
Upper Cretaceous	-	Upper Chalk.

Within this area no borings have yet been made sufficiently deep to reach any rock older than the Chalk.

CHAPTER II.—UPPER CHALK.

The only surface exposures of this rock occur at Sherfield English, in the north-east corner of our area near Otterbourne, and at the extreme north-west; but Chalk undoubtedly underlies the whole district. The Chalk immediately beneath the Eocene rocks in the Southampton district appears never to belong to the higher zones, for these were destroyed before the Reading Beds were laid down. According to Dr. C. Barrois the highest part of the Chalk now preserved belongs to the zone of *Marsupites*.* It is well seen just outside our area in the railway and road-cutting north of Otterbourne; but within the area sections are few and poor. The chalk seen at the surface is soft and white, with small flints; it yields the small *Offaster pilula* (Figs. 1, 2, 3), an echinoderm characteristic of the *Marsupite* zone.

OFFASTER PILULA, LAM.

(Twice natural size.)

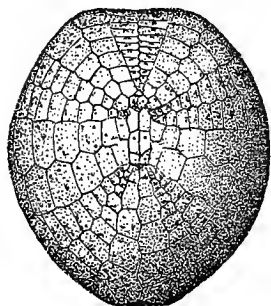


Fig. 1.
Upper surface.

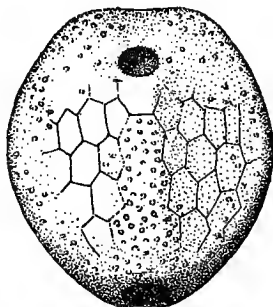


Fig. 3.
Lower surface.

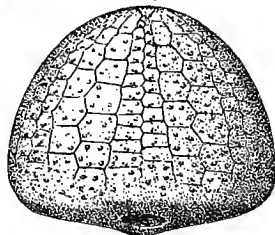


Fig. 2.
Front view.

In a well on Southampton Common the Chalk was reached at 453 feet, and was penetrated to a further depth of 860 feet, making a total depth from the surface of 1,313 feet. The upper

* "Recherches sur le Terrain Crétacé Supérieur de l'Angleterre et de l'Irlande." p. 39. *Mém. Soc. Géol. du Nord*. 1876.

part of this Chalk is described as "chalk with flints," but the lower strata are so peculiar that the section communicated by Messrs. Easton and Amos is here quoted:—

	Feet.
Eocene deposits	452 $\frac{1}{2}$
Chalk with flints	817 $\frac{1}{2}$
do. with flints and of a brown colour	19
do. with flint, light and very free	1 $\frac{1}{2}$
do. blue and cloggy	14 $\frac{1}{2}$
do. dark blue with flints and sponges	2
do. dark blue with veins of clay	2
do. do. very cloggy	4 $\frac{1}{2}$
	<hr/>
	1,313 $\frac{1}{2}$

It was mentioned above that at Otterbourne great part of the Upper Chalk, including the whole of the *Belemnitella* zone is missing. In the Isle of Wight the total thickness of the Chalk with flints is 1,350 feet; but on making allowance for the missing strata, which reappear in the Isle, and also allowing for increased thickness in that direction, it seems that 817 feet in the Southampton well ought to take us nearly to the base of the Upper Chalk. Below that depth we find strata that suggest the Chalk Rock and the marly and flintless Middle Chalk, the blue colour being a not uncommon characteristic of the lower strata when found at great depths. If this correlation is correct, the total thickness of the Chalk at Southampton is probably 1,200 or 1,250 feet; though we have no means of obtaining direct measurements of the lower beds.

It is probable that the two small exposures west of the Test may belong to the *Belemnitella* zone, which is certainly represented a mile or two outside this Map, towards Salisbury. There is, however, no section visible either at Sherfield English or at Harestock.

CHAPTER III.—READING BEDS.

The Reading Series throughout the Hampshire Basin has a fairly uniform thickness of about 100 feet. This is somewhat surprising when we take into account the extreme variability in the lithological character of the deposits. In one place the whole mass consists of red, purple, and green-mottled plastic clay. Then there is an abrupt change and from top to bottom it becomes a coarse sand with small splinters of flint and very pervious. In the deep well on Southampton Common an extremely interesting variation is met with, for beneath a mass of red-mottled clay, 100 feet thick according to one account, 78 feet thick according to another, was found a thin bed of green sand and pebbles a foot or two in thickness. No fossils are recorded from this green sand in the well; but in the neighbourhood of Sherfield English and Fordingbridge similar deposits contain masses of oysters, pointing to marine conditions, unlike those under which the plastic clay seems to have been laid down. Within the area described in this Memoir no other determinable fossils have yet been discovered in the Reading Series, though fragments of drifted lignite can here and there be found. Elsewhere the plastic clays yield only land-plants, and appear to be of lacustrine origin.

The Reading Series around Southampton and in the southwestern part of our area is usually buried deeply beneath newer deposits; but it crops out along our northern limit, and again on the crest of the Portsdown anticline, whence it extends into our area at Swanwick.

To commence with the last-named district, we find close to Swanwick the western extremity of the main exposure which stretches eastward to Portsdown. Only a few feet of the uppermost part of Reading Series is laid bare, and this appears to be altogether sand, though there are no clear exposures. Immediately outside the area a stiff dark-grey clay makes its appearance 20 feet or so beneath the basement-bed of the London Clay. There is no section; but the character of the clay suggests that plant-remains may be found in it.

Three inliers, also brought up by the Portsdown anticline, and exposed in small valleys draining towards the Hamble, again show the upper part of the series, probably to a maximum depth of 40 feet. The deposits are brown or light-coloured sands, sometimes with fragments of lignite.

The northern outcrop near Otterbourne calls for little remark, red-mottled clay and sand appearing to alternate, though no continuous exposures were found. In the area west of Romsey sections are better, the total thickness of the Reading Series being about 70 feet. Commencing with the lowest deposits,

Mr. Whitaker notes the following section immediately above the inlier of Chalk near Birchwood and close to the northern margin of the Map:—

	Feet.
Grey and puce mottled clay	5+
Sand with green grains; lower part clayey; small green-coated flints and an oyster at the base	1½
Chalk; top foot or so with irregular holes filled with green sand.	

Above the mottled clay come, apparently, beds of sand, followed by a mass of flint-shingle. This shingle has been mapped by Mr. Whitaker as forming the upper part of the Reading Series; I should be more inclined to correlate it with the basement-bed of the London Clay, for the parts that I examined seemed always to belong to a thin sheet immediately below the London Clay, which here has no other Basement Bed. A pit close to the high road, and due south of the Chalk inlier just alluded to, shows 12 feet of flint pebbles; which are also dug for road-making in several pits further west. The exposures towards Whiteparish call for no comment, except that better sections can be found just outside that part of our area. The pebble-beds continue to be found at the base of the London Clay as far west as our district extends.

CHAPTER IV.—LONDON CLAY.

Though London Clay occupies a considerable area at the surface in the northern half of the Southampton district, yet it is not easy to ascertain its exact thickness. The Southampton Common well, which should decide the question, leaves the true junctions and thicknesses of the different deposits somewhat uncertain, though the strata between 75 and 382 feet may probably be referred to the London Clay. This gives a thickness of 307 feet, which agrees well with that found in the Isle of Wight, where measurements in the cliff give 233 feet in Alum Bay and 320 feet in Whitecliff Bay. The classification adopted by Prestwich* and in this Memoir places the whole of the shelly beds passed through in the Southampton well in the London Clay, they being followed above by sandy deposits unfossiliferous or containing only vegetable remains. The full account of this well will be found on page 59; the fossils from it, given in the subjoined list, are to be found in the Edwards collection, now in the British Museum, (E)†, in the collection of the Geological Survey (S), or are recorded by Prestwich (P). These last are only mentioned when they add to the list species about which there is not likely to be much doubt; for Prestwich's list was compiled from various sources, and many of the specimens cannot now be traced.

Mollusca from the well on Southampton Common.

(S = Geological Survey, E = Edwards Collection, P = Prestwich.)

- P *Anomia anomialis*, *Lam.* (= *lineata*, *Sow.*).
- S *Arca*.
- E *Cardita Brongniarti*, *Mant.*
- E ——— *elegans*, *Lam.*
- E *Cassis ambigua*, *Sol.*
- E *Crassatella plicata*, *Sow.*
- P *Cyprina scutellaria*, *Lam.* (= *planata*, *Sow.*).
- P *Cytherea obliqua*, *Desh.*
- E ——— *proxima*, *Desh.*
- P ——— *suberycinoides*, *Desh.* var.
- S ——— *suessoniensis*, *Wat.* (= *tenuistriata*).
- S ——— ? sp. (cf. *elegans*, *Lam.*).
- S *Modiola simplex*, *Sow.*
- E ——— *subcarinata* ? *Lam.*
- E *Nucula consors*, *S. V. Wood.*
- E *Ostrea flabellula*, *Lam.*
- SE *Glycimeris* (*Panopæa*) *intermedia*, *Sow.* (Fig. 6).
- S *Pectunculus brevirostris*, *Sow.* (Fig. 5).
- E ——— *decussatus*, *Sow.*
- SE ——— *spissus*, *S. V. Wood.*

* "On the probable Age of the London Clay, and its Relations to the Hampshire and Paris Tertiary Systems." *Quart. Journ. Geol. Soc.*, vol. iii. pp. 354-409. (1847.)

† See "Systematic List of the F. E. Edwards Collection," by R. B. Newton. (1891.)

- E *Pholadomya margaritacea*, Sow. (Fig. 7).
 P ——— *virgulosa*, Sow.
 P *Pinna affinis*, Sow. (Fig. 4).
 P *Protocardium plumsteadianum*, Sow.
 P *Teredo antenautæ*, Sow.

 E *Dentalium* (*Entaliopsis*) *annulata*, Newt.

 ES *Aporrhais* *Sowerbyi*, Mant.
 S *Calyptrea aperta*, Sol. (= *trochiformis*, Lam).
 E *Cancellaria læviuscula*, Sow.
 E *Cingulina* [*chiasta* Edw. MS.].
 P *Fusus* (*Chrysodomus*) *complanatus*, Sow.
 E ——— [*crebrilineus*, Edw. MS.].
 PS ——— (*Leiostoma*) *pyrus*, Sol.
 E ——— (*Pisania*) [*antiqua*, Edw. MS.].
 E ——— *interrupta*, Pilk.
 E ——— [Morrisii, Edw. MS.].
 P ——— (*Trophon*) *tuberosus*, Sow.
 E ——— *porrectus*, Sol.
 P ——— *Koninckii*, Nyst. (no other record).
 E *Murex spinulosus*, Desh.
 ES *Natica hantoniensis*, Pilk.
 ES ——— *labellata*, Lam.
 E *Pleurotoma crassa*, Edw.
 E ——— *denticula*, Bast.
 E ——— *flexuosa*, Goldf.
 E ——— *gomphoidea*, var. *avita* Edw.
 E ——— *Keelei*, Edw.
 E ——— *nodosaria*, Edw.
 E ——— *Prestwichii*, Edw.
 E ——— *rotundata*, Edw.
 E ——— *simillima*, Edw.
 E ——— *stena*, Edw.
 E ——— *symmetrica*, Edw.
 E ——— *terebialis*, var. *gyrata*, Edu
 E ——— *tereticosta*, Edw.
 E ——— *teretrium*, var. *crebrilinea*, Edw.
 E ——— — *tuberculata*, Edw.
 E ——— *turpis*, Edw.
 E *Pyrula Smithii*, Sow.
 E *Rostellaria lucida*, Sow.
 E *Turritella Dixoni*, Desh.
 E ——— *terebellata*, Lam.
 E *Typhis muticus*, Sow.
 PE *Voluta elevata*, Sow.
 E ——— *spinosa*, Linn.

 P *Nautilus* (*imperialis* or *Sowerbyi*).

Prestwich has also recorded *Fusus angusticostatus*, Mell., *F. Koninckii* Nyst., *Pyrula tricostata*, Desh., *Turritella imbricataria*, Lam., and *T. sulcifera* Desh., but these determinations cannot now be verified. He also mentions *Ditrupa* and wood as occurring. Illustrations of some of the commoner fossils are given in Figs. 4, 5, 6, and 7.

Making Southampton our starting point, as yielding the best section in the district, we find that there is an exposure in each of the valleys north of the town, though at the Common the London Clay is hidden beneath newer deposits. The Map will show the exact position and extent of the inliers, and it only

emains to describe the sections of interest. In Southampton itself several wells reach shelly London Clay (see pp. 59-65).

FOSSILS OF THE LONDON CLAY

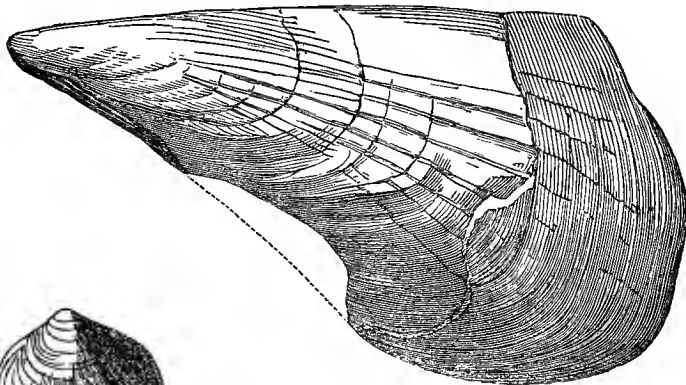


Fig. 4. *Pinna affinis*, Sow.

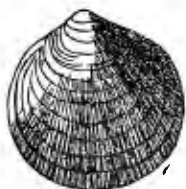


Fig. 5. *Pectunculus brevirostris*, Sow.
($\frac{1}{2}$ natural size.)

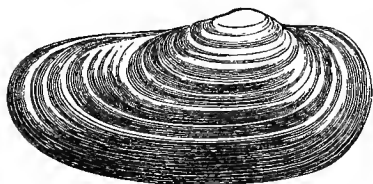


Fig. 6.
Glycimeris (Panopæa) intermedia, Sow.



Fig. 7. *Pholadomya margaritacea*, Sow.

They call for no remark, except that in these also thin pebble-beds occur at various horizons, as they do in the Isle of Wight.

The surface exposures in the inlier immediately north of Southampton were noted by Mr. Whitaker, from whose description the following account is copied. "At Bitterne Station there were some blocks of fossiliferous stone, from the London Clay, found in making the piers of the railway bridge over the Itchen. One contained little else than a number of large *Pinna*, another was full of *Pectunculus* with one *Cytherea* ?, and others (in the garden) were full of *Turritella*. There was also a piece of concretionary sandstone, perhaps drifted. On the east shore of

the Itchen a small pit, touching the cottage garden and road north-eastward of Bitterne Manor Farm, showed in the year 1884, on the eastern, and higher, side merely a trace of gravel over brown and grey sandy clay, like London Clay (and which I take to be the upper part of that formation), with traces of shell at one spot, 6 feet or more. The western side, under the hedge of the garden, gave a rather peculiar section, as follows :—

Gravel resting rather irregularly on cement-stone, following to some extent the irregularity of the junction, and up to about a foot thick but absent in the middle part.

Clay, as before ; reaching up to the gravel in the middle part.

The irregularity in the cement-stone led one to think that the stone might have been formed, to a great extent, by segregation after the deposition of the gravel ; on the other hand it may have, been the comparative firmness of the stone that stopped the denudation of the clay by the water depositing the gravel."

Other sections in this neighbourhood, including some highly fossiliferous exposures at St. Denys, have been described by Mr. J. W. Elwes,* who records about twenty species of mollusca, now preserved in the museum of the Hartley Institution.

The exposures in the northern part of the Southampton inlier are few and small, and the London Clay sinks beneath the river-level when the east and west syncline near Eastleigh is reached. It reappears in the main escarpment, where Mr. Whitaker notes the following sections :—

"Section in a brickyard at Brambridge, near Bishopstoke (1858).

Blue and brown London Clay, with septaria :—

Teredo, *Ostrea*.—Junction with the bed below sharp and somewhat waved.

Basement-bed. Brown loam, with a few scattered small flint pebbles at the top, and with very friable fossils.

Pectunculus ? 2 sp., *Panopæa* ?, *Nucula*, *Ditrupea* (casts), and a cast of a large bivalve (*Cyprina* ?). Not bottomed.

In 1884 I was unable to make out to which of the many brickyards, old and active, at Brambridge the above note referred, in none of which either could I find any shells in the basement-bed.

"In a small pit, in the bottom of an old pit, in the field north of the lane from Leyland's brickyard to the Steam Saw Mills (in six inch Sheet 58) there was (1884) what seemed to be a junction-section, as follows :—

Basement-bed of the London Clay.—Brown loam, bedded with layers of clay, near bottom a few small flint-pebbles of reddish clay (derived from the Reading Beds). In the lowest of the clay-layers were impressions of leaves at one spot.

Reading Beds.—Brown Sand."

* *Geol. Mag.*, 1884, p. 548 ; *Proc. Hants Field Club*, No. 4, p. 80 (1890)

At Crowd Hill Brickyard Mr. Whitaker noted brown sandy clay (grey where unweathered) with many fossiliferous septaria. The fossils determined by Mr. Sharman are:—

Wood, bored by *Teredo*.
Ditrupa.
Crustacean claw.
Cardita Brongniarti, *Mant*.
Cytherea tenuistriata, *Sow*.
Diplodonta.
Glycimeris intermedia, *Sow*.
Pinna affinis, *Sow*.
Buccinum labiatum, *Sow*.

Calyptræa trochiformis, *Lam*.
Cancellaria læviuscula, *Sow*.
Fusus bifasciatus, *Lam*.
Natica hantoniensis, *Sow*.
Pleurotoma.
Rostellaria lucida, *Sow*.
Solarium pulchrum, *Sow*.
Turritella Dixoni, *Desh*.
—— terebellata, *Lam*.

Along the eastern margin of our area the London Clay is more or less sandy and pebbly towards the base, but clayey above. Fossils have only been noticed in the lower beds in the Swanwick district, for though the Brick- and Tileworks at Lower Swanwick show a section 20 feet deep in brown clay, grey below, and another brickpit north of the railway exposes 12 feet of similar deposits, no fossils could be found in either at the time of my visit. Mr Whitaker examined the railway-cuttings before they were sloped, and found pebbles at several points in the basement-bed, as well as clay with septaria containing *Turritella* a few feet higher in the series and close to Swanwick Station. Small exposures of the London Clay can also be seen at several points in the banks of the Hamble; but these call for no comment, as they are unfossiliferous and the clay is usually disturbed by slipping.

Taking next the inliers which mark the continuation in a north-westerly direction of the Swanwick anticline, we pass that north of Southampton, which has already been described, and come first to a small inlier in the valley west of Bassett. In this there is no exposure, though the junction of clay below with Bagshot Sand above is marked by a feature and rushy ground. The next inlier is much larger, about a square mile in area; but only shows one pit, in the upper part of the London Clay due east of Rownhams Church. Mr. Whitaker notes only that this large old pit shows loam, with a gravelly and sandy top.

London Clay reappears on the east side of the Test Valley, west of Toot Hill. Mr. Whitaker notes at the Toothill Brickyard "sandy clay, brown top, rest dark-grey, with shells (friable), septaria (fossiliferous), and pyrites 9 feet. Mr. Bennett (the worker) said they had gone down 30 feet in the 'blue clay,' which was stronger lower down." The top of the London Clay rises above the 200-foot contour at Toot Hill, but no trace of either London Clay or Bagshot Sands can be found on the west bank of the river, the inlier seeming to mark the abrupt termination of the Portsdown Anticline in this direction.

The London Clay is again met with in the main outcrop around Sherfield English. It is here decidedly thinner and more sandy than at Southampton, though no exact measurements can be obtained and sections are few. In most places it is better described as a brown loam than as a clay. At its base is usually

found the bed of flint-pebbles of doubtful age, already alluded to as perhaps belonging to the London Clay, perhaps to the Reading Series. Towards the top also there is a pebble-bed, well seen in the road south of Bagfield Copse, which may possibly form the base of the Bagshot Series, though it seems to go more naturally with the marine London Clay below than with the coarse, angular, and probably estuarine sands of the Bagshot Series above. I have not observed this pebble-bed elsewhere within our district, and an exact note of its position may be useful. It is first seen in the road half a mile west of North Common and close to the cottage above the stream. It reappears on the west side of the stream in the road at about the same level, and there the section is better, the shallow cutting showing loam with perfectly rounded flint-pebbles resting on fine sand. The only foreign pebble that could be found was one of red jasper, like those already known in the Reading Beds and Bagshot Series further west. There is again some trace of this pebble-bed in the same road just at the limit of our district, and the evidence seems to show that it is an impersistent seam lying about 20 feet below the base of the Bagshot Sands—at any rate the main feature of the sand appears to occur about 20 feet higher than the pebbles. Two miles further west, outside the district here described, the Hart Hill Brickyard shows an excellent section through somewhat similar beds. There marine fossils, *Cardita planicosta* (?) and *Turritella imbricata*, occur six feet above a seam of pebbles; but at that point also it is uncertain whether the sandy loam in which the fossils occur should be classed with the Bagshot Sands or as a sandy modification of the London Clay, or even as Bracklesham Beds unconformable on London Clay. This section will be described in the Ringwood Memoir (Sheet 314). Both these localities need further examination and a better series of fossils before we can decide whether the pebble-beds are on the same horizon, and whether they mark or do not mark the junction of two formations.

This completes the description of the London Clay in our district. The area occupied by this formation consists largely of woodland and cover; for the land is cold and wet, though not so heavy as in the London Basin. The soil is often greatly modified by downwash from the Bagshot Sands, which rise to a somewhat higher elevation and dominate the flatter clay-lands.

CHAPTER V.—BAGSHOT SANDS.

The Bagshot Sands form a variable series, consisting of moderately fine sands, bedded loam, and lenticular masses of flint-pebbles. To the east they have a thickness perhaps not exceeding 15 feet. Westward, however, they become more important, for they occupy the surface over a considerable area west of the Test and north of the New Forest. They expand also to a thickness of 200 feet or more, and contain slight traces of white pipe-clay like that which becomes so important still further to the west.

It will be most convenient to commence our description of these strata with the eastern outcrop, where the Bagshot Sands sweep round the Portsdown anticline near Bursledon. The steep scarp which runs east and west near Sarisbury cuts through about 30 feet of sandy beds, which lie between the loams of the Bracklesham Series and the London Clay, though the exact relation to the deposit below is not quite clear. In a pit by the side of the high-road leading to Swanwick sand is seen, covered irregularly by laminated loam. This apparently represents the junction with the Bracklesham Series above. About 300 yards further west sand has been dug to a depth of 10 feet, and close to the Hamble brown sand again occurs below the Bracklesham Series. Beyond these there are no sections along the southern outcrop, and no trace of anything but sand.

The steep scarp on which Bursledon stands is evidently composed of similar sands, which would here seem to be 50 feet in thickness. About a mile further north the character of the deposits changes slightly, for a bed of flint-pebbles comes in near the top of the series. The sand-pit a quarter of a mile north-east of Free Hills shows the following section :—

	Feet.
Bracklesham } Laminated loam	4
Beds. }	
Bagshot } Loamy sand and pebbles -	1
Sands. } Fine buff sand -	10

The pebble-bed may here belong to the Bracklesham Beds, and not to the Bagshot Sands. At Heathhouse Farm there is a similar section.

As the outcrop again curves round to the east the strata thin out as they do further south. There are no clear sections; but a small exposure on the west bank of the river gives evidence of coarse loamy sands, more like the deposits towards Bournemouth.

Continuing to follow the crest of the anticline westward we find that the Bagshot Sands are hidden beneath the Bracklesham Series where the land is high, but have been reached in a well at Netley Hospital, at a depth of about 300 feet below the sea

(see p. 58), and reappear in the Itchen valley near Bitterne. The Bitterne Park Brickyard, east of the Cobden Bridge, as seen in 1884, is thus described by Mr. Whitaker: "The sand-pit just east of Middle Lease Copse gives the following section:—

"Brown loam, up to 6 feet or more, with black flint-pebbles at the base, sometimes for 6 inches [base of Bracklesham Beds].

"Light-coloured sand, which has been worked to a depth of about 10 feet, when it becomes so wet as to be a quicksand. This is underlain by more clayey beds on the west, and is probably Lower Bagshot.

"Just east and higher is another pit, in grey and brown loam, which has been worked to a depth of 30 feet, when the sand is reached. At one point, not the highest, was an irregular patch of gravel and sand over the loam.

"Northwards this pit shallows almost to nothing; but at the N.E. corner of the yard (in May, 1884) was a pit showing a little of the loam, with pebbles at the base, over sand, which had been worked to nearly 20 feet, when it became a running sand. Just westward another pit showed a mass of gravel gently scooping into the sand.

"I take it that these sections show the junction of the Bracklesham Beds and the Bagshot Beds, which latter (clayey lower down) are underlain by London Clay at no great depth, Bognor rock having been found in the bed of the river at the piers of the Cobden Bridge. The low-level gravel just north contains many black flint-pebbles, probably derived from the pebble-bed noted."

At Bevois Mount brickyards, between Valley road and the main road (Bevois Hill and Bevois Valley) Mr. Whitaker notes that "The higher pit, on the north, is shallow, and shows gravel resting irregularly on sand, with partings of loam, this loamy sand often rising to the surface. The southern pit, almost touching, is much deeper, and its section as follows:—

Gravel, resting very irregularly on the bed below, and its lower part sometimes hardened by iron-oxide.

Light-coloured bedded sand, up to about 20 feet seen; a few feet more in smaller holes on the west. *Lower Bagshot* (?).

"A shallow pit at a rather lower level, close to the houses of the main road, is in laminated loam, suggestive of the passage down into London Clay; but perhaps merely the representative of Lower Bagshot clay." These pits are now all built over; but new sections are often exposed in foundations and drainage works.

Along the northern outcrop the Bagshot Series between Durley and Bishopstoke consists of light-coloured false-bedded sand, with seams of flint-pebbles, especially in the upper part. The total thickness apparently does not exceed 30 feet, and on the west of the Itchen, north of Eastleigh, Mr. Whitaker has doubtfully mapped the Bracklesham Beds as resting directly on London Clay, without any intervening sands. Near Otterbourne the Bagshot Series reappears, but consists mainly of flint-pebbles, this type of deposit continuing westward along the northern

boundary of our district almost as far as the River Test, where the strata thicken and become more like normal Bagshot Sands. The following notes and sketch by Mr. Whitaker will illustrate better the nature of the deposits near Otterbourne:—

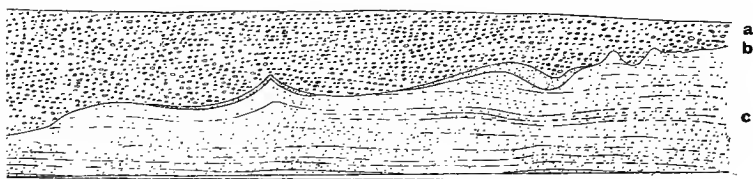
“The excavation for the circular Reservoir of the Southampton Waterworks on Otterbourne Hill Common gave an interesting section of the junction of the Bagshot Pebble Beds with the London Clay, which indeed was the first of the kind I had seen (1886), as elsewhere the Pebble Beds are divided from the London Clay by sand. Figure 8 is from a sketch of about 25 yards of the section at the southern part of the reservoir, which was the best.

Fig. 8. Section at the Reservoir on Otterbourne Hill Common.

(W. WHITAKER.)

About S.S.E.

About N.N.W.



Bottom of Reservoir.

a. Bagshot Pebble Beds. In parts of the reservoir there were some pebbles with the long axis more or less vertical.

London Clay. { *b.* Small local sandy patches, bright ochreous brown.
c. Brown and grey loam, more or less bedded (some more marked layers, as shown), more clayey toward the bottom. Partly discoloured (downward) by infiltration of water and loss of iron.

The other (northerly) side showed a like section, but the junction had a more even slope eastward.

“The large pit a few yards off, toward the road, is carried a rather greater depth and showed over fifteen feet of Pebble Beds. At an Excursion of the Geologists’ Association, in 1887, some small quartz-pebbles were found here, a very rare occurrence in these beds.”

The Bagshot strata brought to the surface in the anticline north of Southampton are also sandy but thin. They are so generally exposed in pits and brickfields worked mainly for the Bracklesham loams, that the details can more conveniently be given in the next Chapter, in which the Bracklesham Beds are described. Prestwich refers about 110 feet of strata at Southampton to the “Lower Bagshot Sands”*; but the deep well on the Common (see p. 60) suggests the lesser thickness of 30 feet,

* Quart. Journ. Geol. Soc., vol. iii. pl. xiv. (1847).

which is more in accordance with other sections in the neighbourhood, and with the range of the marine fossils.

In the region west of the Test the Bagshot Sands exhibit a considerably greater development and are more like those seen further west, on the Dorset coast, and in Alum Bay. Around East Wellow, for instance, the thickness cannot be less than 100 feet, and the road-cutting near the Church exposes bedded buff sand with seams of white clay-pebbles, and a four-inch seam flint-pebbles. A few flint-pebbles occur also near the base; but the higher part of the series, as far as can be judged in the absence of clear sections, consists of white or buff sand of moderately fine grain and containing small splinters of flint. Southward, over and around Shelly Common, a bed of laminated grey loam has been worked for bricks to a depth of about 6 feet; it can be seen in Paulton's Brickfield, at the south-west corner of the Common, but yields no fossils.

The disused brickyard south of the high-road at West Wellow is interesting as showing white and grey clays greatly resembling the pipe-clays of Alum Bay and Poole, though in our district it is too sandy to be used for anything finer than tiles. These clays are said to have yielded leaves, though I could find none in the much weathered section. They are apparently on about the same horizon as the Poole clays, and may well be their equivalents.

Laminated purple and carbonaceous clays that occur near the top of the series north of Bramshaw Church resemble more nearly the higher leaf-bearing clays of Bournemouth Cliff, though at Bramshaw they have as yet yielded no fossils and are not clearly exposed. Similar carbonaceous clays associated with white sands are again seen near the western limit of our area; but sections in the Bagshot Series are not plentiful and their exact position cannot be fixed. At the point where we leave them the Bagshot Sands have probably thickened to 200 feet; but we have no means of obtaining exact measurements. They form sandy barren heaths, much of which is flat, waterlogged, and peaty.

CHAPTER VI.—BRACKLESHAM SERIES.

The Bracklesham Series differs from the Bagshot Sands below in the constant recurrence in it of masses of glauconitic green-sand or glauconitic loam; and these green beds where unweathered yield marine fossils. The Series contains also white sands, as well as laminated and carbonaceous loams like the leaf-bearing brickearths of Bournemouth cliffs; but taking it as a whole it is a marine deposit, and in this is distinguished from Bagshot Sands, which seem to be in the main of fluvatile origin. The base of the Bracklesham Beds is usually marked by green loam with large grains of glauconite, or more rarely by lenticular masses of flint-pebbles; and as both the formations are of economic value, sections of the junction are not uncommon near the towns. It must be confessed, however, that in the absence of sections, fossils, or noticeable feature over great part of our area, it is by no means certain that the upper and lower limits have always been drawn on the same horizon in different parts of the Map. The boundaries must be taken as marking a change in the nature of the deposits, rather than as indicating any undoubted correlation. I believe that throughout the area now to be described the lower boundary of the Bracklesham Series has been drawn nearly on the same horizon; but the upward limit is much more doubtful, for there is a gradual passage into the Barton Clay, and even in the excellent coast sections of the Isle of Wight the exact boundary is uncertain and difficult to trace.

These marine strata, in contradistinction to the Bagshot Sands below, increase in thickness from west to east, instead of from east to west. Their thickness is apparently about 200 feet at Bramble Hill, increasing to over 320 feet at Netley, in a boring that commences some way down in the series. The total thickness near Southampton Water may be over 400 feet.

It will be most convenient to commence the description of the Bracklesham Beds at the south-eastern limit of our district and work northward and westward towards the fossiliferous sections around Brook and Bramshaw. Beginning therefore with the exposures on the foreshore of Southampton Water, we see south of Chilling at low tide a wide expanse of dark-green or black glauconitic sand, similar deposits occupying the lower part of the cliff up to about 15 feet from the beach. No fossils were observed, and it is not clear to what part of the series these strata belong. Similar deposits, more loamy towards the base, extend northward to the Bagshot outcrop at Sarisbury.

Between the Hamble and the Itchen the coast is much obscured by mud or talus, or else planted or built over. The wells at Netley (see page 57), however, will give a good idea of the lithological character of the deposits, though nothing can be said as to the fossils. It will be noticed that though most of the strata are greenish loams or sands there are also three or four

FOSSILS OF THE BRACKLESHAM BEDS.

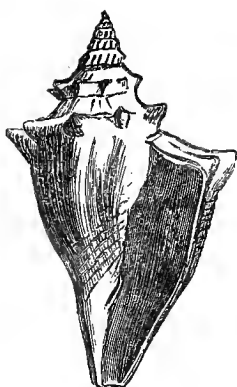


Fig. 9.
Voluta luctatrix, *Sol.*

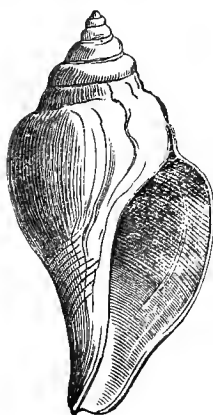


Fig. 10.
Fusus (Leiostoma)
pyrus, *Sol.*

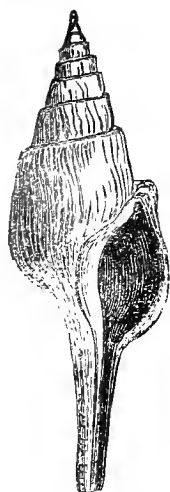


Fig. 11.
Fusus (Clavalithes)
longævus, *Sol.*



Fig. 12.
Xenophora agglutinans,
Lam.



Fig. 13.
Turritella imbricataria, *Lam.*



Fig. 14.
Rimella rimosa, *Sol.*

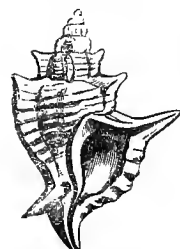
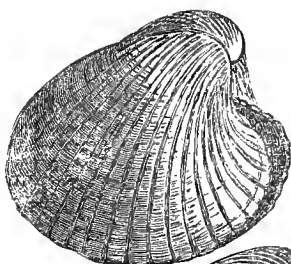
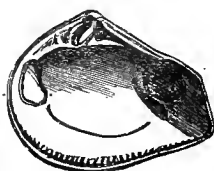


Fig. 16.
Cardita planicosta, *Lam.*

Fig. 15.
Murex asper, *Sol.*



Fig. 17. *Crassatella sulcata*, *Sol.*



intercalated thin carbonaceous seams, such as characterise this series nearly everywhere. The deepest well is 331 feet, of which all but the lowest 11 feet seem to belong to the Bracklesham Series. How far below the base of the Barton Clay the uppermost deposit in the Netley well may be is uncertain, for the junction of these two deposits is hidden somewhere beneath Southampton Water, and we have no means of calculating the dip. From 50 to 100 feet of the uppermost Bracklesham strata may be missing.

The exposures in the railway-cuttings near Bursledon were of little interest, the deposits being greenish sandy clays without fossils, and the same must be said of the cuttings near Botley. Mr. Whitaker notes, however, a new well at the latter place, close to the church, in 15 feet of grey sand, the lower part crowded with shells, including *Cardita*, *Turritella*, *Astarte*, *Nucula*, *Corbula*, and *Cerithium*. Similar shelly deposits have been recorded in several wells at Botley.

In the valley just eastward of Bitterne a number of brickyards were noted in 1884 by Mr. Whitaker, as showing sections of the Bracklesham Beds, sometimes with gravel above and sometimes with good junctions with the Bagshot Sand below:—

“On the northern side of the high road an upper pit gave the section below:—

Some nests of gravel.

Bracklesham Beds.	{	Grey pipe-clay, up to 3 feet at the north-western and higher part.
		Grey and ochreous-stained sandy clay, 6 or 7 feet.
		Grey and buff loam, up to 4 or 5 feet shown.

This must nearly reach to the beds at the top of another pit, near the road, which continued the section as follows:—

Bracklesham Beds.	{	Brown loam up to 5 feet.
		Brown loam, with flint pebbles, up to 15 inches.

Bagshot Sand, nearly white, with a little current-bedding in parts, 18 feet shown.

There was a hollow (or an old filled-in pit?) of brown loam, with patches of gravel, chiefly at the base, which cut into the sand to the depth of 7 or 8 feet at the higher part of the pit; at the lower part this loam comes down and has been worked.

“A small pit in the next field eastward showed a like junction of loam, with pebbles at the base, and sand.

“A brickyard on the southern side of the road showed a like section, but the junction was not always so easy to make out.

Gravelly wash (? gravel comes on above).

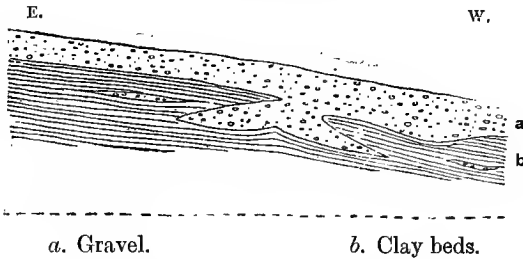
Bracklesham Beds.	{	Grey pipe-clay (as before).
		Brown sand (not shown in the other pit), up to 3 feet, but nipped out in two places.
		Grey sandy clay (as before, but only 3 to 5 feet thick); in one part red mottling occurs at the top, near the outcrop, apparently from per-oxidation of iron.
		Grey and ochreous-stained loam, 15 feet or more.
		Loamy pebble-bed (the pebbles in the upper part) with layers of ironstone (one layer at the base); up to 2 feet.

Bagshot Sand, light-coloured, 10 feet shown.

At one part, a little down the slope westward to the bottom of the valley, a mass of brown gravel was seen, over and wedging into the grey clayey beds, part of which seems to be actually in the gravel, as shown in Fig. 18.

Fig. 18. Brickyard at Bitterne.

(W. WHITAKER.)



Another pit, just southward and facing the valley-bottom westward, showed a mass of brown stony loam or sandy clay sloping down the valley. At one place this stony bed also spreads, in like manner, under Bracklesham clay. Just above these pits was a small gravel-pit. Another brickyard just southward, up to lane, shows:—

Gravel, up to 7 feet; at the W. resting regularly on the beds below on the E. somewhat irregularly, and wedging into them.

Bracklesham Beds.—Brownish clayey sand and loam. Some grey loam lying about, and some shown a little lower.

At the north-western corner of the yard the Bagshot Sand has been worked by what may be called mining. In a pit in Bracklesham loam there were two shafts, close together, passing through the loam to the pebble-bed, at a depth of from 15 to 20 feet from the natural surface of the ground, and then into the sand beneath, in which galleries have been driven. This section shows that there is here but little room for an outcrop of the sand, the bottom of the valley being close by, to the west.

“Another brickyard on the other side of the lane, close by, showed some grey clay, in a small pit, and then in the large pit below, grey loam. It looked as if sand had been got (beneath a wash of gravel and sand) at the bottom of the yard, between the two roads.

“In another brickyard, close by to the south-east, and just opposite the Elephant and Castle, all along were traces of gravel-wash, and at the highest part irregular gravel, pipes of which seemed to follow the waving in the loam beneath:—

Bracklesham Beds.	{	Laminated loam, waved at top, and at one place puckered along the wavy planes. This puckering (or rippling?) occurs also in places where the beds are even. Loam, and beneath this, at the western end, grey sandy clay.
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"Still another brickyard on the other side of the valley south-westward, at the north-eastern corner of Sholing Green, had a pit nearly reaching up to the hedge bounding the green, which gave the following section :—

A little gravel, resting very irregularly on the beds below, and on the north sloping down the valley-side.

Bracklesham Beds.	{	Traces of ferruginous sand, at the highest parts grey and buff loam, more or less laminated and with some small nests of sand ; about 20 feet.
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A pit a little to the south, at the back of some gardens, seems to have been dug for the sand, which is probably a bed in the loams. A notable thing here is the way in which the Drift sand, with gravel at the base, slopes down the side of the valley."

During the excavation of the older Docks at Southampton excellent exposures of fossiliferous Bracklesham Beds have been seen, and these according to the Rev. Osmond Fisher are equivalent to the beds full of *Nummulites levigatus* seen at Selsey, and at Bracklesham Bay in the Selsey peninsula.* They are therefore low down in the series, and are below the fossiliferous strata found at Brook and Bramshaw. The deposits consist of greenish-grey loamy sands or clay with much glauconite, and a seam of flint-pebbles. The fossils recorded are included in the table at the end of this Chapter. The excavation of new docks at Southampton has lately exposed extensive sections of Bracklesham Beds beneath ancient river and estuarine deposits, and beneath the present sea-level. These excavations were carefully noted and collected from by Messrs. Shore and Elwes, from whose paper† I copy the following description of the strata seen :—

"(a) Dark clay, generally green-tinted, and more or less sandy, extending over the northern half of the excavation, apparently unfossiliferous.

"(b) Similar green sandy clay, containing abundance of fossils, especially *Sanguinolaria*, occupying most of the remainder of the dock area.

"This bed and the successive ones were well exposed in the deepest drainage trenches. A rather bright green sandy clay with a small proportion of black grains (glauconitic), small nodules of ironstone, thin patches of lignite, and occasional pebbles ; fossils abounding in a high state of preservation, many of them having a reddish tinge. *Sanguinolaria Hollowaysii* occurs in pairs in the position in which it lived, with *Voluta spinosa*, *Pseudoliva ovalis*, *Cardita planicosta*, *Crassatella Sowerbyi*, *Solen obliquus*, *Natica mutabilis*, *Voluta Selseiensis*, *Mesalia multisulcata*, a small *Pectunculus*, and many of the small species which occur in the sand above. The fossils are scattered rather thinly throughout, not forming beds.

"Towards the south side and highest part of the greensand appears *Cytherea striatula*, and the matrix presently loses its sandy character.

"(c.) A bed of clay in which this species occurs in myriads with *Bifrontia Landunensis* (?) and a small *Pisania*. A few small shelly concretions occurred in this bed, some of which showed the shells on the surface finely preserved.

"(d.) Above this clay lies a bed of small oysters (*O. tenera*) in a more sandy matrix, and on this a local patch of slightly clayey sand, of light puce grey tint, weathering a yellowish brown, with a considerable proportion of

* "On the Bracklesham Beds of the Isle of Wight Basin." *Quart. Journ. Geol. Soc.*, vol. xviii., pp. 65-94. (1862.)

† "The New Dock Excavation at Southampton." *Proc. Hants Field Club*, No. III., pp. 43-56. (1889.)

fine black grains, and abundance of small shells, *Cytherea striatula*, *Mesalia fasciata*, *Crassatella Sowerbyi* (immature), *Corbula cuspidata*, *C. longirostris*, *Cardita elegans*, *Tellina* (?), *Pisania*, *Arca modioliformis*, *Arca lævigata*, *Lutetia Parisiensis*, *Bifrontia Landunensis*, *Tellina plagia*, *Pectunculus pulvinatus*, *Turbinolia*."

The following notes referring to the sections of Bracklesham Beds around and north of Southampton are contributed by Mr. Whitaker. The dates are given, as the exposures in the neighbourhood of a large town alter rapidly, and many of these are now hidden.

Coxford Brickyard, N.W. of Shirley (1884).

Gravel, up to 10 feet thick, resting irregularly on the next.

Bracklesham	{	Bedded sand, with loam (chiefly in upper part), up to about 15 feet, passing into : Peaty sand and loam—almost a peat in parts, up to about 3 feet. Greenish-grey clay, getting sandy downwards, and then being a clayey sand or loam 5 feet shown.
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The beds rise slightly north-eastward.

"The pit at the brickyard on the western side of the valley at the southern part of Portwood Park and near the turning in Spring Road gave a fine junction-section, which was noted at various times, as the pit was cut further back, the beds being :—

Gravel.

Bracklesham Beds.	{	Sandy clay and loam, brown and greyish, bedded, up to about 10 feet (1892 ? more later). Loam, with pebbles, chiefly in a scattered layer in the top foot or so, and in a layer at the base, about 3 feet.
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Bagshot Sand, with here and there a pebble in the top part. Mostly some 6 inches or more nearly white; then very bright ferruginous (mottled), a foot or more; passing down into light-coloured. Several feet.

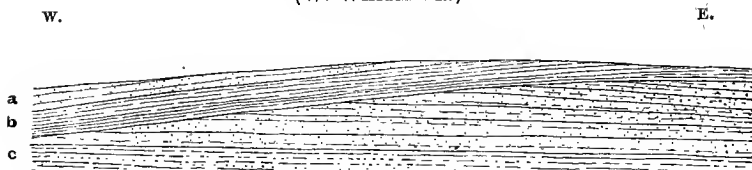
Some pretty orange-coloured bands occurred in the Bracklesham Clay, simulating bedding; but they were curved (after a gravel-hollow) and clearly due to infiltration and consequent oxidation of iron.

"On the other side of the valley a like section was also noted just north-eastward; but has since been hidden, and yet another to the south of the last, near Park Road.

"A most interesting section was shown in 1894 by the cutting back of the slope between Duke's Road and Portwood Lawn, in order to get level ground for building the row of cottages along the former. The Bagshot Sand was seen to differ a good deal in composition from what had been seen in neighbouring sections, south-westward and north-eastward, and the Bracklesham Beds were found to cut across the Bagshot Sand westward. A later opening, just eastward, showed a like occurrence in that direction, the former division coming down almost to the road. Fig. 19 is a sketch of the original section, not drawn to scale, and represents a length of about 125 yards.

Fig. 19. Section between Duke's Road and Portswood Lawn, Southampton.

(W. WHITAKER.)



Traces of gravel in places (not shown).

Bracklesham Beds. { *a.* Alternations of clayey, loamy and sandy beds, in great part inaccessible and for the most part laminated.
b. Clayey beds, with pebbles at the base.

Bagshot Sand. Loamy. The bottom 8 feet or so blackish (peaty), and unlike anything in any other Southampton section.

The side-cuts, at either end, showed a dip into the hill northward.

"In the valley of Portswood Park there was in 1884 a set of pits giving an almost continuous section up the eastern side to a point opposite the back of Balmoral Terrace (Portswood Road), the beds shown being as follows:—

Gravel. Traces only on the south; several feet thick further north.

Bracklesham Beds. { Grey loam, partly brownish; about 10 feet on the south, but thinning away on the north, from the rise of the beds.
 Loamy pebble-bed, the pebbles chiefly in layers at top and at bottom, but a few elsewhere, sometimes as a discontinuous layer; up to about 3 feet.

Lower Bagshot. Light-coloured, sharp sand, iron-shot at top, a few feet shown on the south and more on the north, from the slight rise of the beds.

"On the opposite (western) side of this little valley, due west of St. Denys Railway Station, a smaller pit again showed the junction of the pebbly loam with the sand beneath.

"A temporary pit in the little triangular Green, E.N.E. of St. Luke's Church (Newtown), showed 15 or 20 feet of light-coloured sand, which, with the evidence of the sections to the north and north-east, I should class as Lower Bagshot.

"A pit in the narrow space between Park Road and Osborne Road, just west of St. Denys Station, gave the following section:—

Gravel, up to 6 feet or more; resting irregularly on the bed below.

Bracklesham Beds. { Brown and grey loam, up to about 6 feet passing down into:—
 Loam, rather lighter in colour (more of a grey), with small black flint-pebbles, chiefly at top and bottom, the rest of the bed having but few; resting in a gently waved way on the bed below, and to some extent 'dragged' down the slope eastward; about 2 feet.

Light-coloured sand. ? Bagshot.

This section, therefore, agrees with those of the Bitterne Park Brickyard (p. 13), and the whole point to a rise of the beds, with an outcrop of Bagshot Sand and possibly of London Clay.

"At the brickyard on the eastern side of Southampton Common, at its northern end, the junction of the Bracklesham Beds and the Bagshot Sand was seen (1893) close to the Common. The pebbles at the base of the former were scattered in the loam, and some of them were large. The Bagshot Sand was loamy, and with thin layers of clay, so as to be practically a loam, holding water and worked for bricks.

"A smaller pit, on the other (eastern) side of the little valley, showed gravel over loam and clayey sand; but no pebbles were seen.

"In 1895 there was a good section in the pit just N. of Titlark Farm, nearly half a mile south-westward of Chandler's Ford Railway Station, the order of the beds, as shown in various parts of the pit, being as follows:—

Finely bedded Clay, with sandy partings.	{	Brown clay, several feet, passing down into very dark grey clay, 2 or 3 feet.
		Sandy layer, of varying thickness, on E. a bed of sand.
		Very dark grey clay, several feet.
Sand, with peat or lignite.	{	Peaty layer, with pyrites and lignite.
		Light-coloured and peaty sand, partly loam, several feet.
		Peaty bed and water.

There was a heap of the peaty earth, as if it were used, and a piece of wood in the form of lignite. At one part, too, were some small septaria, from the lower part of the clay (then near the surface), in some of which the very fine septa were lined with pyrites, partly iridescent. The water, of which there were many pools, was of a deep bright brown, from the iron in it, probably derived from the continuous layer of pyrites nodules, a few of which were large, though most were small and of twig-like shape. There is here a slight westerly, or north-westerly, fall in the beds."

The Bracklesham Beds of the New Forest have been so well studied and described by the Rev. Osmond Fisher, and sections other than those opened for the purpose of obtaining fossils are so rare that we cannot do better than follow in the main Mr. Fisher's account, adding notes of what has been seen during the revision of the Map, and notes of the fossils recently obtained by Captain Hicks Beach.

Over most of the area west of the Test the Bracklesham Beds consist of glauconitic sands and loams; this much can be seen in ditches and foundations, but there is little other evidence. The first section of interest met with in going westward is in the brickfield east of Cadnam, where 15 feet of glauconitic shelly brickearth is exposed, yielding shark's teeth, *Fusus pyrus*, *Cardita planicosta*, etc. If we follow the Cadnam River upward to the point where it forks at the south end of Brook Common we reach the spot where so many pits have been opened solely

to obtain the fossils which are here exceptionally well preserved; this is the "Brook" locality of Edwards and Wood's Monograph of the Eocene Mollusca. Mr. Fisher's account is as follows: "After passing through a covering of clay, a thin bed of dark-green sand is reached, full of shells. Single valves of *Cardita planicosta* are common. There are numerous small *Cerithia* in this bed, of several species. *Fusus polygonus* is also not uncommon, as also *Pseudoliva ovalis*. The bed is about 8 or 10 inches thick. Beneath it we come upon very stiff lead-coloured clay, in which *Corbula pisum* soon begins to make its appearance; and, after passing through about 4 feet of this clay, we reach a sandy layer of a somewhat greenish tint. In this many good specimens are to be found, especially of *Pleurotoma attenuata*. The clay then becomes less sandy, and is crowded with *Corbula pisum*, other fossils occurring sparingly for about 2½ feet. We then reach a bed of dark sand with shells, chiefly (but by no means all) broken. There are a large number of single valves of *Cardita planicosta* at this level; and, when these are passed, another layer of shells, mostly broken, is usually found, containing several rare species, and among them many specimens of *Voluta horrida*, a species known only by a single broken specimen from Bracklesham before I found it at this place. Hard grey clay, with intermittent layers of *Corbula*, and but few other species succeed this bed." This deposit Mr. Fisher correlates with a very fossiliferous bed (marked *d* in his sections) in White Cliff Bay and in Bracklesham Bay, where it occurs about two-thirds of the way up in the series.

Nearly a mile higher up King's Garn Gutter we come to a bridge where the stream again forks. This is Hunting Bridge, another well-known locality for Bracklesham fossils, which are obtained from pits sunk close to the stream about 200 yards below the bridge. The deposit now seen is a glauconitic shelly loam with large *Dentalium*; but below this Mr. Fisher records, on the authority of Mr. Henry Keeping, who collected there, about 20 feet of dark-green sandy clay, with fossils scattered throughout. The deposit Mr. Fisher correlates with a stratum near the top, and considers to be "the highest fossil-bearing bed belonging to the Bracklesham series which has been met with in the New Forest." It is therefore higher than anything seen by Mr. Fisher in Bracklesham Bay.

To the west and south-west of Bramshaw fossiliferous sections are to be seen at various points along the course of Shepherd's Gutter. The original "Bramshaw" pits from which the Edwards collection was made were just west of the cultivated fields and south-south-west of Butcher's Corner. It would be impossible without special excavations to improve on Mr. Fisher's account, which again will be followed.*

"Passing through some soft blue clay, the first part of the fossiliferous bed reached, about a foot thick, is crowded with *Turritella curinifera* in clay. Then we have a few inches of

* *Op. cit.* p. 80.

stiff blue clay, in which occur *Triton nodulosus*, Edw. MS., and *Pleurotoma ligata*, and then from three to four feet of very dark clayey sand, with abundant shells. The larger shells are at the bottom of the bed. At the base is a layer full of *Pecten corneus*, which have lost their fresh brown tint. The *Nummulina variolaria* is by no means uncommon in this bed, and is usually to be found attached to the specimens of *Phorus agglutinans*. Beneath this bed are clays, perhaps 10 feet thick; and then a thin fossil-bed, with *Pecten corneus* abundant, and many of the smaller shells of the bed just described. This is succeeded by dark and very sandy clay, with scarcely any traces of fossils. *Cardita planicosta* is rare at this locality. On following the brook a few hundred yards downwards, through the length of two fields, the Corbula-clays, belonging to the next succeeding fossil-bed (*d*), may be made out in a weathered condition in the bank of the stream. A very few feet beneath this stratum, coarser sand with grains of silicate of iron come in. I place the Bramshaw or Shepherd's Gutter Bed in the horizon of XVII. (*b*). [That is to say it corresponds with a stratum 180 feet below the Barton Clay in White Cliff Bay.]

"The argument for the position of the Shepherd's Gutter Bed is of this kind. It is succeeded at the interval of a few feet (there is no opportunity of taking a measurement, but it may be 20 or 30 feet) by the 'Brook' Bed, a deposit of a marked character [see above]. The extraordinary abundance of *Corbula pisum* in the upper portion of this bed, the abundance of *Pleurotoma attenuata*, elsewhere rare, and the presence of *Voluta horrida* render it peculiar. There is also an individuality about a fossil-bed which cannot be fully appreciated except by one who has personally worked it. The characters of the 'Brook Bed' belong also to bed No. 13 at Stubbington, and to the Cypræa-bed, No. 19, of Selsea, in Bracklesham Bay; there is therefore a presumption that the three are equivalent. Now there is, at a short interval above the beds 13 of Stubbington and 19 of Selsea, a remarkable deposit of *Nummulina variolaria*: at Selsea that Nummulite is accompanied by *Alveolina* in abundance, and by other Foraminifera. Thus we have two beds at Stubbington and Selsea similar in their general character, and also similar in sequence. Passing to White Cliff Bay, we find a *Nummulina variolaria* bed, No. XVII., intermediate in character between those of Stubbington and Selsea, containing a larger proportion of Nummulites than at Selsea, but with *Alveolina* and other Foraminifera of Selsea which are not found at Stubbington. The bed is based on a sandy deposit, as is that of Selsea, containing in both places numerous *Tellina*. The sand-rock is soon succeeded by a bed (XIV.) full of *Corbula pisum*, which, as far as I was able to examine it, appeared to agree with the Cypræa or 'Brook' Bed (*d*) of the New Forest, Stubbington, and Selsea. Thus it seems to admit of little doubt that the *Nummulina variolaria* bed (the 'Clibs') of Selsea, the Nummulina-bed of Stubbington, and *Nummulina variolaria* bed of White Cliff Bay are equivalent.

"Now, the *Nummulina variolaria* bed of White Cliff Bay contains rather a peculiar assemblage of *Pleurotoma* as well as the *Rissoa cochlearella*, which are found at Shepherd's Gutter, as are also its fossils, except the *Alveoline*, absent also at Stubbington; and it is shown to occupy a position with regard to bed *d* similar to that occupied by the Shepherd's Gutter Bed; therefore the argument from fossil contents and sequence renders it most probable that the two are equivalent, and therefore that the Shepherd's Gutter Bed is equivalent also to the *Nummulina variolaria* beds of Stubbington and (the 'Clibs') of Selsea.

"But the argument is still further strengthened thus. Let it be granted that the Shepherd's Gutter Bed is equivalent to No. XVII. of White Cliff Bay; it is therefore equivalent to the *Nummulina variolaria* bed of Stubbington. Now, there is at Stubbington, about thirty feet higher up, a very remarkable bed, No. 20, containing *Paracyathus caryophyllus* and *Dentalia*; whilst a bed with similar contents is also found in the New Forest, at Hunting Bridge, not many feet above the Shepherd's Gutter Bed. It will be seen that the above contains also the data upon which I have ventured to differ from former observers respecting the line of separation between the Bracklesham and Barton Beds at White Cliff Bay, and to place it slightly higher up.

"At about a mile and a quarter S. by W. of Shepherd's Gutter [*i.e.* about midway between the 'Hunting Bridge' and 'Brook' sections above described] is a fossil-bed, in its leading features very similar to that at Shepherd's Gutter. The stratum covering the fossil-bed is soft blue clay. To this succeeds a bed of clay crowded with *Turritella imbricata* and *T. carinifera*, and then a bed of dark sand with many shells. This last is not so thick as at Shepherd's Gutter, averaging about $1\frac{1}{2}$ foot. There are not so many broken shells; but the percentage of tolerably perfect shells is perhaps larger. Beneath it we find decayed *Pectines cornei* in a sandy clay. *Cardita planicosta* is very rare. This bed is, I believe, a continuation of the Shepherd's Gutter Bed, and is on the horizon of XVII.

"A section, by digging and boring, gave:—

	Ft.	In.
Superficial soil	2	0
Soft, weathered, blue clay, with selenite and <i>Turritellæ</i>	7	0
Fossil-bed (<i>b</i>)	1	0
Stiff slate-coloured clay	3	6
A thin fossil-bed, with <i>Pecten corneus</i> * say	0	3
Purplish, very sandy clay (not pierced), probably <i>c</i> of Bracklesham	2	0

The ground north and west of Bramble Hill is unfortunately too obscure to allow me to trace these zones any further than Mr. Fisher has examined them. On the steeper slopes the strata appear to have been decalcified, so that the channels show nothing but glauconitic sand and loam.

* Corresponding probably with the thin fossil-bed, containing *Pecten corneus*, mentioned as occurring at Shepherd's Gutter.

FOSSILS FROM THE BRACKLESHAM BEDS.

E = Edwards Coll. (now in the British Museum). B = British Museum (General Coll.). S = Geological Survey Coll. H = Hicks Beach Coll. Sh = Shore and Elwes.

	Brook.	Branshaw.	Hunting Bridge.	Southampton.
<i>Fishes.</i>				
<i>Ætobatis</i> n. sp. - - -	...	S		
<i>Amia</i> ? -	H			
<i>Cœlorhynchus</i> rectus, <i>Ag.</i>	...	B		
<i>Gadus</i> elegans, <i>Koken</i>	H			
— cf. elegans -	S H			
<i>Galeocerdo</i> latidens, <i>Ag.</i>	H			
<i>Galeus</i> sp. - - -	H			
<i>Lamna</i> Vincenti, <i>Winkler</i> -	H			
<i>Myliobatis</i> acuta, <i>Ag.</i> -	H	S		
— Dixoni, <i>Ag.</i>	...	S		
— Toliapica, <i>Ag.</i>	...	S		
— sp. -	...	S		
<i>Odontaspis</i> elegans, <i>Ag.</i>	H	B	B ?	B
— cuspidata, <i>Ag.</i> -	H			
— macrota, <i>Ag.</i>	H	B		
<i>Otodus</i> trigonalis, <i>Jaekel</i> -	H	H		
<i>Pagellus</i> ?	H			
<i>Cephalopoda.*</i>				
<i>BeLOPTERA</i> belemnnoidea, <i>Blainv.</i>	...	B		
<i>BeLOSEPIA</i> Oweni, <i>Sow.</i>	...	E S		
— sepioidea, <i>Blainv.</i>	E	E	E	
<i>Scaphopoda.</i>				
<i>Dentalium</i> fissura, <i>Lam.</i> -	E	E		
— grande, <i>Desh.</i>	...	E	E	
— striatum, <i>Sow.</i> -	E	E H S	E H	Sh
— substriatum, <i>Desh.</i>	E	E	E	
<i>Gasteropoda.</i>				
<i>Volvulella</i> lauceolata, <i>Sow.</i>	E			
<i>Bulla</i> attenuata, <i>Sow.</i>	E	E	E	
— angystoma, <i>Desh.</i>	E			
<i>Phyline</i> expansa, <i>Sow.</i>	E	E		
<i>Scaphander</i> Brongniarti? <i>Desh.</i> -	...	...	E	
— [ocellus, <i>Edw. MS.</i>] -	...	...	E	
<i>Ringicula</i> Langlassei, <i>Morlet</i> -	E			
<i>Solidula</i> simulata, <i>Sol.</i>	...	...	E	
<i>Actæon</i> subinflatus, <i>Orb.</i> -	E	...	E	
<i>Teinostoma</i> [callistum, <i>Edw. MS.</i>] -	...	E		
— [innominatum, <i>Edw. MS.</i>]	...	E		
<i>Nerita</i> parisiensis, <i>Desh.</i> -	E			
— pentastoma, <i>Desh.</i>	E			
— tricarinata, <i>Lam.</i>	...	...	...	Sh
<i>Patella</i> striata, <i>Sow.</i>	...	E		

* As a matter of convenience, in the order of the Mollusca and to a large extent in their nomenclature, the "Systematic List of the F. E. Edwards Collection" has been followed.

	Brook.	Branshaw.	Hunting Bridge.	Southampton.
<i>Hipponyx dilatatus</i> , Lam.	...	...	E	
<i>Capulus squamæformis</i> , Lam.	E	E		
<i>Calyptraea aperta</i> , Sol.	E	ES	E	Sh
— <i>obliqua</i> , Sow.	E	E		
— <i>striatella</i> , Nyst.	H	HS	H	
<i>Ampullina intermedia</i> , Desh.	...	E		
— <i>mutabilis</i> , Sol.	E	E	E	Sh
— <i>parisiensis</i> , Orb.	...	E		
— <i>patula</i> , Lam.	EH	ES		
— <i>ponderosa</i> , Desh.	E	E		
— <i>rustica</i> , Desh.	H			
— <i>semipatula</i> , Desh.	...	E		
— <i>sigaretina</i> , Lam.	...	E		
— <i>sphærica</i> , Desh.	EH			
— <i>splendida</i> , Desh.	E			
— <i>Willemeti</i> , Desh.	ES	E		
<i>Sigaretus clathratus</i> , Gmel.	E	E	H	Sh
<i>Natica cepacea</i> , Lam.	E	...	E	
— <i>ambulacrum</i> , Sow.	S	S		
— <i>epiglottina</i> , Lam.	...	E		
— <i>labellata</i> , Lam.	E	E	...	Sh
— <i>obovata</i> , Sow.	...	...	...	Sh
— <i>venusta</i> , Desh.	E			
— <i>Hantoniensis</i> , Ptk.	H	H		
<i>Adeorbis lucidus</i> ? Cossm.	E			
— [venator, Edw. MS.]	...	...	E	
<i>Diastoma costellata</i> , Lam.	E	E		
<i>Paryphostoma minor</i> , Desh.	...	E		
<i>Cossmannia expansa</i> , Desh.	E			
<i>Rissoina puncticulata</i> , Desh.	E	E		
— <i>cochlearella</i> , Lam.	...	...	...	Sh
<i>Rissoa</i> [cerithiiformis, Edw. MS.]	...	E		
— <i>turbinopsis</i> , Desh.	...	...	E	
<i>Lacuna</i> [fasciata, Edw. MS.]	E			
— <i>globulosa</i> ? Desh.	E			
— <i>Loveni</i> , Bayan.	E			
<i>Homalaxis Landunensis</i> , DeFr.	E	...	...	Sh
<i>Discohelix patellatus</i> , Sow.	...	E		
<i>Philippia spirata</i> , Lam.	...	...	...	Sh
<i>Solarium canaliculatum</i> , Lam.	E	EH	H	Sh
— <i>plicatum</i> , Lam.	...	EH		
— [Yteniense, Edw. MS.]	E	E		
<i>Xenophora agglutinans</i> , Lam.	E	EH S	E	
— <i>confusa</i> , Desh.	...	...	E	
— <i>cumulans</i> , A. Brongn.	...	...	E	
— [venatrix, Edw. MS.]	...	...	E	
<i>Thylacodes cancellatus</i> , Desh.	E	E	E	
— <i>porrectus</i> , Desh.	E			
— <i>strictus</i> , Desh.	E	E		
<i>Scalaria interrupta</i> , Sow.	E	E		
<i>Tuba sulcata</i> , Ptk.	EH			
<i>Mesalia fasciata</i> , Lam.	...	...	E	
— <i>multisulcata</i> , Lam.	...	...	...	Sh
<i>Turritella carinifera</i> , Desh.	E	E	...	Sh
— [concinna, Edw. MS.]	E			
— <i>granulosa</i> , Desh.	...	EH	H	S
— <i>imbricataria</i> , Lam.	...	EH S	...	S
— <i>sulcifera</i> , Desh.	EH	EH S	EH	Sh
— [venatrix, Edw. MS.]	...	...	E	

	Brook.	Bramshaw.	Hunting Bridge.	Southampton.
<i>Bayania bordacea</i> , Lam.	...	...	E	
<i>Melanopsis carinata</i> , Sow.	...	...	...	E
<i>Melanatria</i> [ignotum, Edw. MS.]	...	...	E	
<i>Batillaria Bouei</i> , Desh.	E	E	E	
<i>clandestina</i> , Desh.	E	E	E	
<i>echinoides</i> , Lam.	H	H		
<i>pleurotomoides</i> , Lam.	E			
<i>Terebralia Bonelli</i> , Desh.	E	E		
[<i>sublamellosa</i> , Edw. MS.]	...	E		
<i>Pyrasus</i> [anglicanus, Edw. MS.]	...	E		
<i>angulatus</i> , Sol.	E			
<i>angulosus</i> , Lam.	E			
<i>Potamides conarius</i> , Bayan	E H	E H S	E H	
<i>conjunctus</i> , Desh.	E	E		
<i>Dixoni</i> , Desh.	E S	E		
<i>emarginatus</i> , Lam.	E			
<i>gradatus</i> , Desh.	H	H		
<i>semicoronatus</i> , Lam.	E			
<i>submarginatus</i> , Orb.	E	E		
<i>Triforis ambigua</i> , Desh.	...	...	E	
<i>Lovenella clavus</i> , Lam.	...	...	E	
<i>prælonga</i> , Desh.	E			
<i>Bittium</i> [convexum, Edw. MS.]	...	E		
<i>Semivertagus unisulcatus</i> , Lam.	E			
<i>Campanile cornucopiæ</i> , Sow.	...	...	E	Sh
<i>Cerithium Brocchii</i> , Desh.	E			
<i>montabile</i> , Lam.	E H	E H S	E	Sh
<i>Niso micromphala</i> , Lowry	E	E	E	
<i>Eulima gracilis</i> , Lowry	E			
[<i>incerta</i> , Edw. MS.]		...	E	
[<i>sororecula</i> , Edw. MS.]	E			
[<i>venatrix</i> , Edw. MS.]	...	...	E	
<i>Odostomia</i> [crassa, Edw. MS.]	E			
[<i>edentula</i> , Edw. MS.]	...	E		
<i>hordeola</i> , Lam.	E			
[<i>subangulata</i> , Edw. MS.]	E			
<i>Obeliscus</i> [eulimoides, Edw. MS.]	...	E		
<i>pyramis</i> ? Desh.	...	E		
<i>Cerithioderma</i> [aciculata, Edw. MS.]	...	E		
<i>pulchra</i> , Desh.	E			
<i>Cancellaria evulsa</i> , Sol.	E H	H	E H	
<i>excellens</i> , Beyr.	E	E S	E	
[<i>eximia</i> , Edw. MS.]	E	...	E	
[<i>globularis</i> , Edw. MS.]	...	E	E	
<i>microstoma</i> , Newton	E	E		
[<i>multilinea</i> , Edw. MS.]	E			
[<i>nassæformis</i> , Wood MS.]	E	E		
<i>nitens</i> , Beyr.	...	...	E	
[<i>pupa</i> , Edw. MS.]	...	...	E	
[<i>reticulata</i> , Edw. MS.]	E			
[<i>venatrix</i> , Edw. MS.]	...	...	E	
[<i>Ytenensis</i> , Edw. MS.]	E	E		
<i>n. sp.</i>	...	E		
<i>Nassa</i> [obtusa, Edw. MS.]	...	E H		
<i>Pseudoliva ovalis</i> , Sow.	E S	E	...	Sh
<i>obtusa</i> , Desh.	H	H		
<i>Pyrula Greenwoodii</i> , Sow.	...	...	E	
<i>nexilis</i> , Sol.	E	...	E	
<i>Strepsidura turgida</i> , Sol.	E H S	E H	E	Sh

	Brook.	Bramshaw.	Hunting Bridge.	Southampton.
Cantharus [ditropis, <i>Edw. MS.</i>]	E	E		
— polygonus, <i>Lam.</i>	E H	E H S	...	Sh
— semiplicatus, <i>Desh.</i>	E	E		
Metula juncea, <i>Sol.</i>	E H	E H S	...	Sh
Pisania [clavicularis, <i>Edw. MS.</i>]	E			
— [crebrilinea, <i>Edw. MS.</i>]	E	...	E	
— [filigera, <i>Edw. MS.</i>]	E	E		
— interrupta, <i>Pilk.</i>	E	E	E	
— [lima, <i>Edw. MS.</i>]	...	...	E	
— [nodicosta, <i>Edw. MS.</i>]	E	E	E	
— [nodigera, <i>Edw. MS.</i>]	E			
— [sindonata, <i>Edw. MS.</i>]	...	...	E	
— [subangulata, <i>Edw. MS.</i>]	E			
Chrysodomus [dentatus, <i>Edw. MS.</i>]	...	...	E	
— antiquus, <i>Sol.</i>		H S		
— errans, <i>Sol.</i>	E H	E H S		
— [gracilis, <i>Edw. MS.</i>]	E	E		
— [Ytenensis, <i>Edw. MS.</i>]	E H	E H S	E	Sh
Leiostoma pyrus, <i>Sol.</i>	E	E		
Clavalithes angulatus, <i>Lam.</i>	E H	E H S	E H	Sh
— longaevus, <i>Sol.</i>	E H	E H S		
— Noae, <i>Chemn.</i>	E	E		
— rugosus, <i>Lam.</i>	E	E		
— [subrugosus, <i>Edw. MS.</i>]	...	E		
— sp.	E			
Fusus [rotundatus, <i>Edw. MS.</i>]	E	E	E	
— porrectus, <i>Sol.</i>	...	S		
— unicarinatus, <i>Desh.</i>	E	E S	E	Sh
Typhis pungens, <i>Sol.</i>	E H	E H S	...	Sh
Trophion undosum, <i>Sow.</i>	...	...	...	Sh
Pteronotus asper, <i>Sol.</i>	E H S	E H S	E H	Sh
— bispinosus, <i>Sow.</i>	E	...	E	
— Caillati, <i>Desh.</i>	E	E	E	
— crassicostratus, <i>Desh.</i>	E	...	E	
— [filigranosus, <i>Edw. MS.</i>]	...	...	E	
— micropterus, <i>Desh.</i>	E	E	E	
— tripteroides, <i>Lam.</i>	E	...	E	
Murex minax, <i>Sol.</i>	E H S	E H S	E H	Sh
Triton [eximia, <i>Edw. MS.</i>]	...	...	E	
— argutus, <i>Sol.</i>	...	H	H	
— Flandrica, <i>Kon.</i>	E	E	E	
— [Ytenensis, <i>Edw. MS.</i>]	E	E		
Latirus funiculosus, <i>Lam.</i>	E	E	H	
— incertus, <i>Desh.</i>	E			
— [rariocostatus, <i>Edw. MS.</i>]	...	E		
— [rudis, <i>Edw. MS.</i>]	E	E		
— uniplicatus, <i>Lam.</i>	...	E H	E H	
— [venatrix, <i>Edw. MS.</i>]	...	E	E	
— n. sp.	E			
Marginella bifido-plicata, <i>Edw.</i>	...	...	...	Sh
Mitra labratula, <i>Lam.</i>	E	...	...	Sh
— parva, <i>Sow.</i>	E	...	E	
— [sulcifera, <i>Edw. MS.</i>]	E			
Voluta Branderi, <i>Defr.</i>	E	E H	E	
— cithara, <i>Lam.</i>	E H	E		
— crenulata, <i>Lam.</i>	E H S			
— horrida, <i>Edw.</i>	E H	H S		
— luctatrix, <i>Sol.</i>	E	E		
— muricina, <i>Brug.</i>	H	E	...	Sh

	Brook.	Bramshaw.	Hunting Bridge.	Southampton.
<i>Voluta maga</i> , <i>Edw.</i>	...	...	E	
— <i>mutata</i> , <i>Desh.</i>	E	E	E	Sh
— <i>nodosa</i> , <i>Sow.</i>	EH	EH S		
— <i>pugil</i> , <i>Edw.</i>	HS	S		
— <i>selseiensis</i> , <i>Edw.</i>	EH S	EH	EH	Sh
— <i>Solandri</i> , <i>Edw.</i>	E	S		
— <i>spinosa</i> , <i>Lin.</i>	H	EH	EH	Sh
— <i>uniplicata</i> , <i>Sow.</i>	EH	E	EH	
<i>Conorbis alatus</i> , <i>Edw.</i>	EH	EH S	EH	
<i>Conus deperditus</i> , <i>Brug.</i>	EH S	EH S	EH	
— <i>Lamarckii</i> , <i>Edw.</i>	E	E		
<i>Borsonia Biaritzana</i> , <i>Rouault</i>	EH	EH S	EH	
<i>Pleurotoma crassi-costa</i> , <i>Edw.</i>	EH	EH S	EH	
— <i>dentata</i> , <i>Lam.</i>	H	H	E	Sh
— <i>goniea</i> , <i>Edw.</i>	H	H	H	Sh
— <i>inarata</i> , <i>Sow.</i>	EH	...	E	
— <i>planetica</i> , <i>Edw.</i>	EH	E	EH	
— <i>terebialis</i> , <i>Lam.</i>	E	H		
— <i>attenuata</i> , <i>Sow.</i>	EH S	EH		
— <i>Fisheri</i> , <i>Edw.</i>	EH	H		
— <i>inflexa</i> , <i>Lam.</i>	EH	EH		
— <i>plicata</i> , <i>Lam.</i>	EH	E	EH	
— <i>pupa</i> , <i>Edw.</i>	...	E		
— <i>pyrgota</i> , <i>Edw.</i>	E	EH	E	
— <i>callifera</i> , <i>Edw.</i>	E			
— <i>conifera</i> , <i>Edw.</i>	EH	EH		
— <i>denticula</i> , <i>Bast.</i>	EH	EH S	E	Sh
— <i>gentilis</i> , <i>Sow.</i>	EH	EH S	E	
— <i>ligata</i> , <i>Edw.</i>	E	EH S	EH	
— <i>reticulosa</i> , <i>Edw.</i>	...		E	
— <i>scalarata</i> , <i>Edw.</i>	E	E	E	
— <i>amphiconus</i> , <i>Sow.</i>	...	H		
— <i>marginata</i> , <i>Lam.</i>	E	...	E	
— <i>prisca</i> , <i>Sol.</i>	E	EH S	EH	
— <i>semi-striata</i> , <i>Desh.</i>	...	E		
— <i>[submarginata]</i> , <i>Edw. MS.]</i>	E			
— <i>[ventricosum]</i> , <i>Edw. MS.]</i>	...	...	E	
<i>Cassis ambigua</i> , <i>Sol.</i>	...	E		
— <i>calantica</i> , <i>Desh.</i>	...	...	E	
— <i>coronata</i> , <i>Desh.</i>	ES	ES	E	
— <i>nodosa</i> , <i>Sol.</i>	ES	E	E	
— <i>[venatrix]</i> , <i>Edw. MS.]</i>	...	...	E	
<i>Harpopsis stromboides</i> , <i>Hermanns</i>	E	E	E	
<i>Ancilla buccinoides</i> , <i>Lam.</i>	EH	EH	E	Sh
— <i>canalifera</i> , <i>Lam.</i>	EH S	EH	E	Sh
— <i>[nana]</i> , <i>Edw. MS.]</i>	E	...	E	
<i>Oliva [pygmæa]</i> , <i>Edw. MS.]</i>	...	E		
<i>Cypræa attenuata</i> , <i>Edw.</i>	...	E		
— <i>cancellata</i> , <i>Edw.</i>	...	E		
— <i>cavata</i> , <i>Edw.</i>	...	E	E	
— <i>orthocheila</i> , <i>Edw.</i>	E			
— <i>tumescens</i> , <i>Edw.</i>	E	E		
— <i>sp.</i>	E			
<i>Terebellum sopitum</i> , <i>Sol.</i>	E	...	E	
<i>Rimella canalis</i> , <i>Cog. & Brongn.</i>	E	E	E	Sh ?
— <i>rimosa</i> , <i>Sol.</i>	...	S	EH	Sh
<i>Rostellaria lucida</i> , <i>Sow.</i>	H	H	H	
<i>Hippochrenes amplus</i> , <i>Sol.</i>	...	...	EH	

	Brook.	Bramshaw.	Hunting Bridge.	Southampton.
<i>Lamellibranchiata.</i>				
Pholas sp.	...	E	E	
Gastrochæna Rauliniana, <i>Desh.</i>	...	E	E	
Cryptomya [semigranulata, <i>Edw. MS.</i>]	...	E		
Neæra [callista, <i>Edw. MS.</i>]	E			
— [lævinscula, <i>Edw. MS.</i>]	...	E		
Corbula costata, <i>Sow.</i>	E H	H	E H	
— cuspidata, <i>Sow.</i>	...	...	...	Sh
— gallica, <i>Lam.</i>	...	...	E H	
— Lamarckii, <i>Desh.</i>	E	E	...	Sh
— longirostris, <i>Desh.</i>	E	E	...	Sh
— pisum, <i>Sow.</i>	E H	E H	H	
— [plicata, <i>Edw. MS.</i>]	E	E		
— rugosa, <i>Lam.</i>	H			
— [venatrix, <i>Edw. MS.</i>]	...	...	H	
Glycimeris (Panopæa) intermedia, <i>Sow.</i>	E H			
Solecurtus Deshayesi, <i>Des M.</i>	...	E		
Cultellus affinis, <i>Sow.</i>	E			
Solen obliquus, <i>Sow.</i>	E	E	E	Sh
Syndosmya Raulini, <i>Desh.</i>	...	E		
— [semiovalis, <i>Edw. MS.</i>]	...	E		
— [soror, <i>Edw. MS.</i>]	E	E		
— [Ytenensis, <i>Edw. MS.</i>]	E			
Gari (?) Hollowaysii, <i>Sow.</i>	...	...	...	Sh
Tellina Branderi, <i>Sow.</i>	...	E ?		
— concinna, <i>Edw.</i>	...	...	...	Sh
— [dubia, <i>Edw. MS.</i>]	E			
— [obliquata, <i>Edw. MS.</i>]	E			
— [pulcherrima, <i>Edw. MS.</i>]	E			
— [subcircularis, <i>Edw. MS.</i>]	E			
— textilis, <i>Edw.</i>	E	E	E	
— [turbida, <i>Edw. MS.</i>]	...	...	E	
— [venatrix, <i>Edw. MS.</i>]	E	...	E	
Tapes [Comptoni, <i>Edw. MS.</i>]	E			
Cytherea [Branderi, <i>Edw. MS.</i>]	E	..	E	
— [filigera, <i>Edw. MS.</i>]	E	...	E	
Cytherea lævigata, <i>Lam.</i>	E	...	E	
— [prælonga, <i>Edw. MS.</i>]	E	E		
— deltoidea, <i>Lam.</i>	...	...	E	
— obliqua, <i>Desh.</i>	...	...	...	Sh
— striatula, <i>Desh.</i>	...	...	...	Sh
— suberycinoides, <i>Desh.</i>	...	E	?	Sh
— [subquadrata, <i>Edw. MS.</i>]	E	E		
— [subtransversa, <i>Edw. MS.</i>]	E	...	E	
— [subtrigona, <i>Edw. MS.</i>]	...	...	E	
— trigonula, <i>Desh.</i>	E	E		
— [venatrix, <i>Edw. MS.</i>]	...	...	E	
Cypricardia isocardioides, <i>Desh.</i>	...	...	E	
Cardium cymbulare, <i>Lam.</i>	E	...	E	
— discors, <i>Lam.</i>	...	...	E	
— fraudator, <i>Desh.</i>	...	E		
— parile, <i>Desh.</i>	E	E	E	
— asperulum, <i>Lam.</i>	E H	...	...	Sh
— porulosum, <i>Sol.</i>	E H	E H	E H	
Chama calcarata, <i>Lam.</i>	...	E		
— fimbriata ? <i>Defr.</i>	...	E		
— gigas, <i>Desh.</i>	...	...	E	
— Selseiensis, <i>S. V. Wood</i>	...	...	...	Sh

	Brook.	Bramshaw.	Hunting Bridge.	Southampton.
<i>Lamellibranchiata</i> —cont.				
<i>Chama turgidula</i> ? <i>Lam.</i>	E			
<i>Diplodonta</i> [attenuata, <i>Edw. MS.</i>]	...	...	E	
_____ dilatata, <i>Phil.</i>	E			
_____ [Eudoridae, <i>Edw. MS.</i>]	E	E		
_____ [obesa, <i>Edw. MS.</i>]	E			
_____ [subrotundata, <i>Edw. MS.</i>]	E	E		
<i>Lucina elegans</i> , <i>DeFr.</i>	E			
_____ [hemilissa, <i>Edw. MS.</i>]	E			
_____ [spinulosa, <i>Edw. MS.</i>]	E	E		
_____ ventricosa, <i>Watelet</i>	...	E		
<i>Erycina</i> [habilis, <i>S. V. Wood MS.</i>]	...	E		
<i>Lutetia Parisiensis</i> , <i>Desh.</i>	E	E	...	Sh
<i>Cardita acuticosta</i> ? <i>S. V. Wood</i>	...	E		
_____ crebrisculcata, <i>S. V. Wood</i>	E	E	E	
_____ elegans, <i>S. V. Wood</i>	E	E	E	Sh
_____ mitis ? <i>Lam.</i>	E			
_____ planicosta, <i>Lam.</i>	E H	E H S	H	S
<i>Crassatella compressa</i> , <i>Lam.</i>	E	E	E	
_____ sulcata, <i>Sol.</i>	...	...	E	
_____ plicata, <i>Sow.</i>	H	H		
_____ Sowerbyi, <i>S. V. Wood</i>	...	...	...	Sh
_____ tennisculcata, <i>S. V. Wood</i>	E	E		
<i>Leda costulata</i> , <i>Desh.</i>	...	E		
_____ minima, <i>Sow.</i>	E	E		
<i>Nucula</i> [exigua, <i>Edw. MS.</i>]	...	E		
_____ Dixoni, <i>S. V. Wood</i>	...	...	...	Sh
_____ minor, <i>Desh.</i>	E	E		
_____ praelongata, <i>S. V. Wood</i>	E	...	...	Sh
_____ sericea, <i>S. V. Wood</i>	...	...	E	
_____ sphenoides, <i>S. V. Wood</i>	E	E		
<i>Trigonocella cancellata</i> , <i>Desh.</i>	...	...	E	
_____ deltoidea, <i>Lam.</i>	...	...	...	Sh
<i>Pectunculus deletus</i> , <i>Sol.</i>	E	E	E	
_____ [incertus, <i>Edw. MS.</i>]	...	...	E	Sh ?
_____ pulvinatus, <i>Lam.</i>	...	E	E H	Sh
<i>Arca appendiculata</i> , <i>Sow.</i>	H S	E H	E H	
_____ eximia, <i>S. V. Wood</i>	E S			
_____ globulosa ? <i>Desh.</i>	...	E		
_____ laevigata, <i>Caillat</i>	...	E	...	Sh
_____ Laekeniana, <i>Le Hon.</i>	E H	E H S	E H	Sh
_____ modioliformis, <i>Desh.</i>	...	...	...	Sh
_____ [ornata, <i>Edw. MS.</i>]	...	E		
_____ planicosta, <i>Desh.</i>	E	E	E	Sh
_____ tessellata, <i>S. V. Wood</i>	E			
<i>Lithodomus Deshayesii</i> , <i>Sow.</i>	E			
<i>Modiola elegans</i> , <i>Sow.</i>	...	E		
_____ hastata, <i>Desh.</i>	E S	E	E	
<i>Pinna margaritacea</i> , <i>Lam.</i>	E	...		
<i>Avicula media</i> , <i>Sow.</i>	E			
<i>Spondylus rarispina</i> , <i>Desh.</i>	...	...	E	
<i>Pecten corneus</i> , <i>Sow.</i>	E H	E H	E H	
_____ reconditus, <i>Sol.</i>	...	...	E	
_____ squamula, <i>Lam.</i>	...	E		
_____ triginta-radiatus, <i>Sow.</i>	H			
<i>Ostrea flabellula</i> , <i>Lam.</i>	E H	E H	E H	Sh
_____ marginidentata, <i>S. V. Wood</i>	E			

	Brook.	Bramshaw.	Hunting Bridge.	Southampton.
<i>Lamellibranchiata</i> —cont.				
<i>Ostrea tenera</i> , Sow.	...	...	E	Sh
—— <i>zonulata</i> , S. V. Wood	...	...	...	Sh
<i>Anomia anomialis</i> , Lam.	...	...	E	Sh
<i>Actinozoa</i> .				
<i>Paracyathus cylindricus</i> , Dunc.	...	E		
—— <i>crassus</i> , E. & H.	...	H		
<i>Turbinolia sulcata</i> , Lam.	H			
<i>Annelida</i> .				
<i>Serpula extensa</i> , Sol.	...	H S	H	
<i>Foraminifera</i> .				
<i>Nummulites variolarius</i> , Lam. -	H S			
—— <i>lævigatus</i> , Brug. - -	...	...	...	S
<i>Plantæ</i> .				
<i>Nipadites</i> (fragments only) -	S			

CHAPTER VII.—BARTON BEDS.

BARTON CLAY.

The Barton Clay is confined to the New Forest part of our area, over which it forms undulating heavy land, largely occupied by oak-woods, or by permanent pasture. The clay is blue and nearly impervious, the amount of glauconitic sand in it seldom being sufficient to allow water to penetrate far. It is rarely seen in section, for the district over which it occurs is but sparsely inhabited and there are few pits. The total thickness of this division may amount in places to nearly 150 feet; though in the entire absence of clear exposures near the base, it is impossible to say whether the lower strata mapped as Barton Clay may not represent the upper part of the Bracklesham Series of other districts. Even with the clear cliff-sections in the Isle of Wight the boundary is a particularly difficult one to follow.

Barton Clay rises above the sea-level on the west side of Southampton Water about a mile south of our area, and soon forms a clayey bluff which overlooks the marshes as far north as Hythe and Marchwood. It was formerly dug in the brickyard at Langdown, and Dibden Brickyard now shows a section of 10 feet of brown loam without fossils. A boring at Winterton Hall seems to penetrate about 40 feet of Barton Clay before reaching the Bracklesham Beds (see p. 56). A boring at Windmill House, Dibden (see p. 54), gave a thickness of 102 feet of clay between the Barton Sand above and some greenish loamy sands below, which latter should, I think, be referred to the Bracklesham Series. Mr. Whitaker, however, refers no less than 349 feet of the strata in this boring to the Barton Clay.* This seems to be much too great a thickness, the green loams being probably the equivalents of the clayey Bracklesham Beds seen at Brook and Bramshaw.

At Marchwood the strike of the Barton Clay turns westward through the Forest, the outcrop widening, though the clay does not seem to be more than 100 feet thick, unless the greenish sandy loams seen in the high-road at Marchwood and Pooks-green belong to this division.

Travelling westward, the next section met with is in a well at Langley Manor, Eling (see p. 55), where, unfortunately, there is the same uncertainty as at Dibden. Perhaps we should refer the uppermost 35 feet of strata in this well to the Barton Clay, the rest to a depth of 310 feet belonging to the Bracklesham Series; but in the absence of fossils it is impossible to feel confident.

* "Hampshire Well Sections" (2nd paper). *Proc. Hampshire Field Club*, vol. iv. pp. 22, 23 (1898).

Another well, at Lyndhurst, published by Mr. Whitaker,* gives the following section :—

	Feet.
[Barton Sand.] { Live yellow sand	21
{ Dead sand	4
{ Live sand	4
(?) { Blue dead sand	22
{ Dead sand and shells	38
{ Dead sand	7
[Barton Clay.] { Sandy blue clay	5
{ Brown clay and shells	4
{ Blue clay and shells	14
{ Blue clay and sandstone	6

The deposits marked as doubtful may include the Chama-beds at the top of the Barton Clay, though these have not yet been recognised away from the coast-section. No record seems to have been preserved as to the fossils met with in the Lyndhurst well.

A little more than a mile north of Lyndhurst I happened to see in 1897 a deep cutting close to the Kennels, made for a mill-race. It showed the following section :—

	Feet.
Brown clay (weathered)	15
Hard dark-blue clay with a decayed Oyster and abundant casts of <i>Corbula</i>	5

The depth to which the fossils have been destroyed by percolating water in this section explains their absence from nearly all the shallow pits and excavations. We have no reason to think that the Barton Clay inland is less fossiliferous than in Barton Cliff, though so few fossiliferous sections have been seen. It is noteworthy that in the clear section of the Kennels the abundant hollow moulds of *Corbula* were entirely overlooked while the clay was in a plastic state, but were conspicuous when a hard slowly-dried block was broken, in order to show a clean fractured surface of Barton Clay in our Museum.

Around Minestead and Castle Malwood, though no clear sections are to be found, we can obtain a rough estimate of the thickness of the Barton Clay. It is about 120 feet thick, and is not noticeably different from the deposit in Barton Cliff. A small pit above the seventh milestone from Ringwood, near Bratley Arch, exposes 16 feet of ferruginous loamy sand, which seems to belong to the upper part of the Barton Clay, though it may be part of the Barton Sand above. Somewhat lower and just above Slufter's Inclosure a well showed 10 feet of green sandy clay. Near the bottom of the valley, in the stream about 300 yards west of Bratley Arch and just beyond the limits of our area, there is a good section of hard dicey blue clay. All these exposures, however, are quite devoid of fossils, and in Bolderwood Walk there are no sections even as good.

Half a mile east of the Knight Wood Oak, just north of the point where the Christchurch road crosses the Highland Water, blue sandy and shelly clay with *Ostrea flabellula* and fish remains occurs in the stream bank.

BARTON SAND.

These sands, formerly called Upper Bagshot Sands, on the supposition that they were the equivalents of the Upper Bagshot Sands of the London basin, are now considered to represent a zone, or perhaps rather a deposit, somewhat newer than anything found among the Eocene strata of the Bagshot district. The fauna of the true Upper Bagshot Sands, as far as it is known, corresponds with that of the Barton Clay of the Hampshire Basin.

Though Barton Sands occupy the surface over a considerable area in the district now under discussion, not much can be said about them, for thus far they have proved entirely unfossiliferous. The deposits consist of fine-grained buff or white sands, rarely containing beds of flint-pebbles, and more rarely scattered angular flints, and usually from 80 to 100 feet in thickness. They form sandy land, occupied by open heath or by pine or beech woods, and though the hills are sufficiently dry there is a great tendency for the lower lands and the valley-bottoms to become peaty and water-logged. The water is usually ferruginous, and often inky where tannin from the peat can combine with the iron; for this reason, and because of their fine grain, the Barton Sands do not form a satisfactory source of water-supply.

Little need be said about this division, except to note the places where clear exposures have been found. It forms the middle part of the bluff overlooking Southampton Water near Cadland. At Langdown the top of the Barton Clay seems to have been worked in the old brickyard, the upper part of which was apparently cut back into the sand. This would leave 50 or 60 feet for the thickness of the sand and gravel above. At Windmill House, however, the well already alluded to (see also p. 54) gives a much greater thickness; but I think that the "blue sand" which yielded so little water more probably represents the loamy "Chama-beds," which have also been worked in the brickyard, than the Barton Sand above. After this deduction the depth to the base of the Barton Sand becomes 62 feet, which corresponds with what the mapping would lead one to expect.

In Denny Lodge Walk fine white sand occurs immediately beneath the Headon Series near North Gate, though the actual junction is not exposed. At Pig Bush, however, at about 20 feet below the Oligocene, there occurs a lenticular mass of flint-pebbles, 6 feet thick, but only traceable a few yards. The next indication of gravelly beds on this horizon is met with about a mile west of Beaulieu Road Station, and just above Matley Passage, where a pit shows 15 feet of fine white sand with rare scattered unworn flints. These deposits are still better exposed in the pits around Lyndhurst, a large one, close to the Tumulus on White Moor, exposing a face of 20 feet of variegated sand with scattered pebbles of flint in the lower part. The flints are often decayed. The base of the sand is seen in Brockishill Sand

Pit in a small outlier two miles north of Lyndhurst. The pit shows:—

Fine sand with black specks and flakes of mica	Feet.
Blue loam (Barton Clay) -	13

At Allum Green I have mapped an inlier of Barton Clay, on the strength of the occurrence in the valley-bottom of some light-blue clay and loam which throws out water. If this is correct the thickness of the sand has decreased to about 60 feet; but it is equally probable that the clay is a bed in the middle of the sand, like that found at Becton Bunny, on the coast, though unrecognised elsewhere. There is no means of settling this point in the absence of sections; for though a well at Lyndhurst, according to Mr. Whitaker, penetrates 96 feet of Barton Sand, the only loamy beds are near the base, and I should be inclined to transfer the 45 feet of "dead sand" to the Barton Clay below (see also p. 36). The sections west of the Highland Water are small and of little interest. No fossils have been recorded from this division within our district; for the sand has been thoroughly decalcified to a considerable depth, and no hollow moulds of fossils were observed in the rare ironstone nodules.

CHAPTER VIII.—HEADON BEDS.

The Oligocene Period is represented by strata belonging to the Lower and Middle Headon and confined to the district between Beaulieu Heath and Lyndhurst. This part of the country being almost entirely forest or open heath, with neither natural sections nor artificial excavations, we are unable to give any good account of the succession or thickness of the strata. As in other areas, the Lower Headon seems to be mainly of lacustrine origin and the Middle Headon marine; but it sometimes looks as though marine strata occurred nearly down to the Barton Sand. Whether the Lower Headon strata thin out northward, or whether part of them have become marine, is not clear.

If we commence our examination, as before, on the east and work westward, the first section is met with in the valley of the Dark Water, close to Little Holbury. Here a pit exposes:—

Plateau Gravel	-	Feet.
Green clay (Lower Headon)		5
Fine sand (Barton Sand)	-	

The clay was also dug formerly in pits on the opposite side of this valley, but these are now overgrown. No fossils could be found.

West of Holbury the Headon Beds are lost under the plateau gravel of Beaulieu Heath for about two miles. Where they reappear at the edge of the plateau above the Beaulieu River we again find green clay resting on fine sand. Above the clay occurs shelly marl (the shells here indeterminable), and above that some more sand without fossils, the total thickness of Headon Beds being about 80 feet.

The railway cutting at the southern limit of our area is now overgrown, though it still shows marl with indeterminable shells. A quarter of a mile to the west, however, at the cross road at Woodfidley, there is clear evidence of the marine beds, a ditch yielding *Cytherea incrassata*, *Ostrea*, and *Cyrena*. The celebrated Whitley Ridge cutting, which formerly yielded so many marine fossils, is just outside the limits of our area.

Grey or green clays, sometimes with recognisable shells, generally *Cytherea*, *Cyrena*, and *Cerithium*, are to be found over the whole of the area between Denny Lodge Inclosure and the Lyndhurst Road, and in Hollands Wood there is an overgrown pit in these shelly strata. Everywhere there would seem to be a sharp junction with the sand below.

The sections nearer Lyndhurst, at Clay Hill, though not much clearer, are interesting, for they show fossiliferous Lower Headon below the marine Middle Headon strata. The best exposure is on the Forest road which passes south-eastward across the

eastern spur of Clay Hill. At first the road is level and sandy (Barton Sand); then comes a slight rise marking the base of the Headon Beds, and in the ditch and in an old clay-pit just above the junction can be found some light-grey marls full of *Potamomya*, such as occur in the Lower Headon Beds of Hordle Cliff. Next above occur green clays with *Cyrena*; but there is no clear section.

Lyndhurst Hill is a well-known locality for Middle Headon marine fossils, though with the exception of the overgrown road-cutting to Emery Down the only sections are in pits purposely sunk for obtaining these fossils. The total thickness of the Headon Beds in Lyndhurst Hill seems to be nearly 100 feet; but the fossiliferous clay formerly dug lies somewhat below the top of the Hill, it appears to be about 50 or 60 feet above the Barton Sand. The old pits lie south of the high-road and just above Christ Church, Emery Down. They now only show traces of grey clay with fragments of *Cytherea*; but they have yielded the following Middle Headon species, now in the Edwards Collection in the British Museum:—

- | | |
|--|---|
| <i>Atys Lamarcki</i> , <i>Desh.</i> var. | <i>Conorbis alatus</i> , var. <i>hemilissa</i> ,
<i>Edw.</i> |
| <i>Bullinella conoidea</i> ? <i>Sandb.</i> | <i>Pleurotoma Hantoniensis</i> , <i>Edw.</i> |
| <i>Natica labellata</i> , <i>Lam.</i> | ———— <i>denticula</i> , <i>Bast.</i> |
| <i>Potamides vagus</i> , <i>Sol.</i> | ———— <i>Headonensis</i> , <i>Morris.</i> |
| <i>Cancellaria pyrgota</i> , <i>Lowry.</i> | ———— <i>transversaria</i> , <i>Lam.</i> , |
| ———— <i>læviuscula</i> , <i>Sow.</i> | var. <i>cypha</i> , <i>Edw.</i> |
| ———— <i>elongata</i> , <i>Nyst.</i> | <i>Ancilla buccinoides</i> , <i>Lam.</i> |
| <i>Strepsidura armata</i> , <i>Sow.</i> | <i>Rimella rimosa</i> , <i>Sol.</i> |
| <i>Cantharus</i> [subcostulatus, <i>Edw.</i>
MS.] | <i>Hippochrenes amplus</i> , <i>Sol.</i> |
| <i>Pisania labiata</i> , <i>Sow.</i> | <i>Corbula pisum</i> , <i>Sow.</i> |
| <i>Clavalithes longævus</i> , <i>Sol.</i> | ———— <i>cuspidata</i> , <i>Sow.</i> |
| <i>Typhis pungens</i> , <i>Sol.</i> | <i>Cytherea</i> [turgescens, <i>Edw.</i> MS.] |
| <i>Marginella æstuarina</i> , <i>Edw.</i> | ———— <i>incrassata</i> , <i>Sow.</i> |
| <i>Voluta suturalis</i> <i>Nyst.</i> , var. <i>con-</i>
<i>tabulata</i> , <i>Edw.</i> | <i>Cyrena obtusa</i> , <i>Forbes.</i> |
| ———— <i>spinosa</i> , <i>Lin.</i> | ———— <i>obovata</i> , <i>Sow.</i> |
| ———— <i>maga</i> , <i>Edw.</i> | ———— <i>gibbosula</i> , <i>Morris.</i> |
| ———— <i>geminata</i> , <i>Sow.</i> | <i>Cardita deltoidea</i> , <i>Sow.</i> |
| <i>Conorbis dormitor</i> , <i>Sol.</i> var. <i>semi-</i>
<i>nuda</i> , <i>Edw.</i> | <i>Trigonocælia deltoidea</i> , <i>Lam.</i> |
| | <i>Arca lævigata</i> , <i>Caillat.</i> |
| | <i>Ostrea ventilabrum</i> , <i>Goldf.</i> |
| | ———— <i>flabellula</i> , <i>Lam.</i> |

CHAPTER IX.—DISTURBANCES.

After the deposition of the formations described in the foregoing chapters there followed a period of disturbance, when the Eocene and Oligocene strata were thrown into a series of folds, and some of these folds affect the area under consideration. In the first place, there is the main trough-like fold of the Hampshire Basin, the northern margin of which is formed by the Chalk which rises along the northern edge of our district, the southern boundary being defined by the corresponding central Chalk-ridge of the Isle of Wight. This fold causes a general southerly dip, which brings in the newer deposits in the direction of Lyndhurst and Beaulieu, and carries the Chalk far beneath the sea-level at those places. More to the south, in the bottom of the trough, even Oligocene deposits later than the Headon Beds are preserved.

The trough of the Hampshire Basin, however, is not a simple synclinal fold, it is made up of a series of minor undulations riding on one big wave, but not necessarily coinciding exactly in direction with it. Of these minor folds the western end of one of the most noticeable passes through the centre of our district, from Swanwick to the valley of the Test, where it finally disappears. This fold, known as the Portsdown anticline, brings up a long narrow ridge of Chalk, which extends for several miles and forms one of the main defences of Portsmouth. Where it enters our area, however, it has become less prominent, and exposes nothing older than the Reading Beds. It steadily dies away and flattens as it is followed westward; but its course is clearly shown on the map by the series of inliers of London Clay which appears along the crest of the arch. The existence of this anticline has probably a good deal to do with the small yield of water in the well on Southampton Common. An underground ridge of this sort may greatly hinder the flow of water in the Chalk.

The other minor undulations are so small as to be unrecognisable without a careful examination of the six-inch map. They are insufficient to reverse the general southerly dip of the strata, and are only noticeable as causing a local flattening—as is seen at Landford in the outliers of Bagshot Sands, and in the extension of the Barton Clay along the Beaulieu River at Yew Tree Heath.

CHAPTER X.—DRIFT.

PLATEAU GRAVEL.

The Oligocene Period was succeeded by a long period of time, represented in our district rather by erosion and destruction of pre-existing strata than by deposition of new masses. We are at present without evidence as to the extent to which the Headon deposits were formerly covered by newer strata, and can only say that in all probability within our area the average depth to which the surface has been planed down since Middle Tertiary time can scarcely be less than a thousand feet. The oldest deposits now remaining of those laid down during this long period of destruction may be of Newer Pliocene date, though the evidence for this is by no means clear.* One is at present, in the absence of fossils, obliged to class these supposed Pliocene gravels with the Pleistocene "Plateau Gravel," though at the same time recognising that this plateau series includes strata of at least two different dates.

The most ancient of the gravels is undoubtedly the large sheet which caps the scarp above Bramshaw at a height of 420 feet above the sea and nearly 300 feet above the plain below. From this point it slopes steadily downward to Bolderwood Lodge, 330 feet above the sea, and is carried on by outliers near Lyndhurst at 300 feet, and perhaps even lower by outliers further south. Some outliers at Chilworth and Bassett seem to belong to the same series, as do others at Bitterne, Thorn Hill, and Netley Hill. The gravel consists of 5 or 10 feet (sometimes more) of subangular flints, mixed with many flint-pebbles and other material derived from the Eocene deposits. Among the less abundant fragments are numerous sub-angular pieces of Greensand chert, a few small silicious pebbles like the radiolarian chert of Devon, and veined-grit and jasper, probably derived also from Devon. Any stratification that may once have existed in these gravels has now been obliterated, through decalcification and irregular subsidence of the strata.

At a somewhat lower level than the gravel just described occurs a second sheet, which slopes downward towards the Solent, and less markedly towards Southampton Water and the Test Valley. The composition of this gravel is identical with that of the older series, from the destruction of which it is in fact principally derived. Perhaps in this case it will be most convenient to trace the deposit northward from the areas in which

* See "Geology of Dorchester" (Sheet 328), pp. 39, 40. *Mem. Geol. Survey*, 1899.

it forms a continuous sheet, to the regions where it passes into high river-terraces, or is represented only by scattered outliers.

An extensive sheet of gravel, containing Palæolithic implements covers great part, of the country between Portsmouth (Map 331) and Bournemouth (Map 329). Near the Solent and English Channel it descends nearly to the sea-level, except where the cliff has been much cut back in later times, as is the case near Bournemouth. When traced inland this sheet is found to rise gradually and steadily till its uniform surface is somewhat broken by a more abrupt slope, which seems to mark the course of an old nearly-destroyed sea-cliff (the Goodwood cliff) at a height of about 140 feet above the present sea-level. The gently inclined gravel plateaus of Beaulieu Heath and of Sarisbury represent this stage; but within our area the old cliff has been replaced by an escarpment facing in the opposite direction, for the bare Eocene strata were more easily destroyed by rain than was the case with the part protected by gravel. It is doubtful whether any of the gravels now preserved are actually of marine origin, though they may well be the fluvial equivalents of the marine strata found at Stone, near the mouth of Southampton Water, and of the still older raised beach of Goodwood.

When the sheet of gravel above described is traced up the valley of the Test it tends to divide into two terraces bounded above by old river-bluffs. The higher of these terraces corresponds with the main sheet, the lower is perhaps slightly newer. As we continue to ascend the river the terraces rise also, though keeping the same general height above the modern alluvium. The higher terrace rises to 275 feet at its western margin in the district west-north-west of Romsey, but falls towards the river so rapidly as to be only 150 feet at its inner edge. On the east side of the Test at Romsey the terrace rises only 145 feet above the sea.

These gravels scarcely call for detailed description; they are fairly clean and coarse ferruginous flint-gravels, usually 10 or 15 feet in thickness, and with the original stratification better preserved than is the case in the older series. On and around Beaulieu Heath there are numerous pits, one of the largest being close to the Roman road at Dibden Purlieu. The gravel is here 10 feet thick, and consists of unworn flints, flint-pebbles, Green-sand chert, Palæozoic grit, schorl-rock, jasper, and a few small fragments of silicified shell-limestone of Purbeck age, probably derived indirectly through the Bagshot Gravels of the neighbourhood of Dorchester.

On the north side of Southampton Water the gravel forms the upper part of a low cliff about 40 feet in height. It is about 10 feet in thickness, and has here yielded Palæolithic implements.* Northward the gravel rises steadily to a height of

* Sir John Evans, "On some Recent Discoveries of Flint Implements in Drift-deposits in Hants and Wilts." *Quart. Journ. Geol. Soc.*, vol. xx. pp. 188, 189 (1864); and "Ancient Stone Implements," 2nd edit. pp. 622-626 (1897). Through the kindness of Sir John Evans, Figs. 20 and 21 have been borrowed from his book.

145 feet at Sarisbury, where it ends in an abrupt scarp overlooking the plain of London Clay 100 feet below.

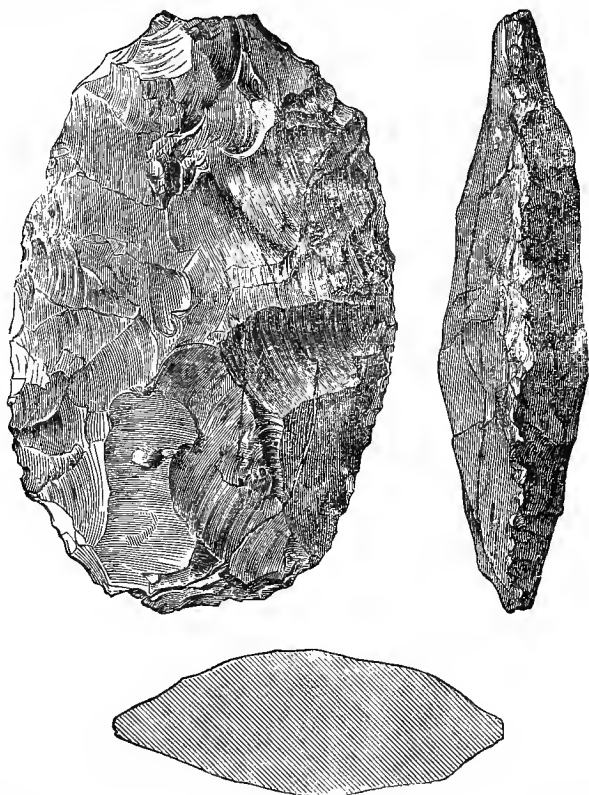


Fig. 20.—Palæolithic Implement from Hill Head. (Sir John Evans, "Ancient Stone Implements.")

Between the rivers Hamble and Itchen the lower edge of the gravel, at a height of about 50 feet, caps a low bluff, facing Southampton Water, but separated from it by a river-terrace about 30 feet above the level of the estuary. In this district also there is a steady rise inland, Netley Green reaching 140 feet and outliers further north rising to 250 feet, though these latter, as already suggested, probably belong to an older series, separated from the lower one by a steeper slope.

The higher parts of Southampton, including the suburbs of Shirley and Portswood, are built on a sheet of gravel, which, like that near Netley, is separated from a newer terrace by a low bluff. The older gravel has been dug extensively at various times, and appears to have an average thickness of about 10 feet. In the Ordnance Survey Office are four Palæolithic implements from a pit (now ornamental water) worked just north of the cemetery in 1872-3; some of them are stated to have been found at a depth of 7 feet. Others in the Southampton Museum are

from a pit on the south side of the cemetery, as is the one shown in Fig. 21, which Sir John Evans has allowed me to reproduce. Numerous others have been found at various places near Southampton, this neighbourhood being very prolific. One specimen obtained by Mr. Dale weighed no less than 3 lbs. 15 ozs.* The gravel consists of the usual mixture of sub-angular flints and Tertiary pebbles in a sandy and ferruginous matrix. The sheet of gravel in which these implements occur so abundantly rises gradually to a height at Shirley of just over 100 feet above sea-level. Then there is a slight bluff, separating it from a somewhat higher gravel on which stands Upper Shirley. This gravel rises to 200 feet, and at a height of more than 160 feet above the sea-level, in the Town Pit, it has yielded Palæolithic implements.

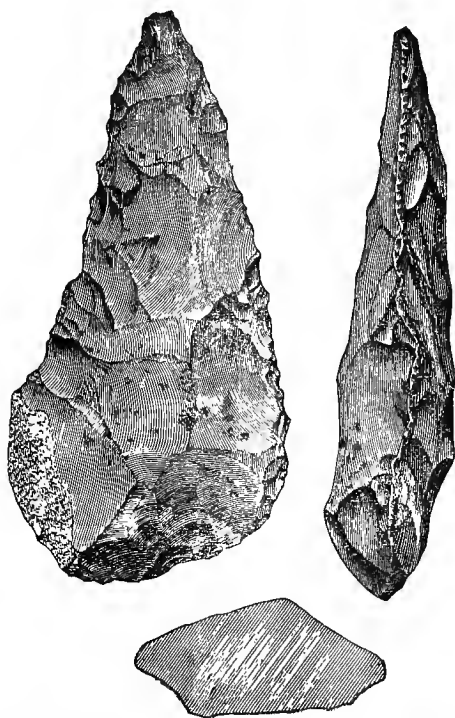


Fig. 21.—Palæolithic Implement from Southampton. (Sir John Evans, "Ancient Stone Implements.")

Outliers of similar gravel occur here and there on each side of the Itchen, and on the east side of the Test, to beyond Romsey, they usually rise to 140 or 150 feet giving place above that level to bare slopes of Eocene strata, except where the country is dominated by older and higher gravel-capped plateaus. The

* See W. Dale, "The Palæolithic Implements of the Southampton Gravels." *Proc. Hants Field Club*, vol. iii. p. 261(1898).

high gravel-capped plateau west of Romsey is somewhat peculiar. It has the appearance of a very ancient terrace of the River Test, for it has a decided fall towards the river and a lesser fall to the south; but on the west, where one might expect to find the ancient river-bluff, the gravel ends in an abrupt escarpment, which rises to 275 feet above the sea where the Salisbury road crosses it. It is not clear whether this gravel belongs to the Palæolithic series or to an older period.

On entering the New Forest area, we again find the Palæolithic gravel forming a curiously flat and even sheet on the plateau of which Beaulieu Heath forms part. Though this gravel sinks at the south-eastern limit of our district as low as 90 feet, and further south falls to the level of the Solent, in the Beaulieu Heath area its surface over several square miles only varies between 120 and 130 feet. Hill Top, the highest point, touches 133 feet. The gravel consists of sub-angular and angular flints and flint pebbles, with rare fragments of silicified shell-beds from the Purbeck, and more Palæozoic material than is found east of Southampton Water. In fact, the proportion of fragments belonging to rocks older than the Chalk increases with considerable rapidity as we travel westward.

The outliers in Denny Lodge Walk and Ashurst Walk lie at a somewhat lower level than would be expected, for they only rise slightly above the 100-foot contour in their higher parts. It will be observed, however, that each of these outliers rests on a hill of the fine-grained water-logged strata of the Barton Sand, and that in every case the cap of gravel tends to take the shape of a dome—both upper and under surface dipping outward in every direction. I believe that this structure is not original, but results from the weight pressing on a mass of quicksand, which is always oozing out and flowing away at the foot of the hill, thus causing a continuous “sagging” of the superincumbent strata towards the free edge. This structure is still better seen in the area south of our district, for there every narrow spur of gravel sinks considerably below the level of the main mass, and the margins are always decidedly lower than pits in the middle of the plateau would lead us to expect. It is obviously unsafe, therefore, to place much reliance on levels as evidence of age of the various patches of gravel, in a district such as this, where the whole foundation is soft and mobile, and slopes of anything beyond a gentle angle are in unstable equilibrium.

The gravel outlier of Matley Ridge rises to a slightly higher elevation, reaching 144 feet at its western end. It contains little Palæozoic material, in this character resembling the high gravel of Stony Cross rather than the lower gravel of Beaulieu and Brockenhurst. The difference arises apparently from the different sources of the gravels, those brought from the north-west having crossed Eocene strata containing little Palæozoic material; while those brought from districts due west crossed the quartzose Eocene gravels of the Dorchester area.*

* See “Geology of the Country around Dorchester,” p. 29. *Memoirs Geol. Survey*, 1899.

LOWER TERRACES AND VALLEY GRAVEL.

The deposits next in age consist of gravels occupying terraces not more than 40 feet above the present stream-level, or spreading in wide flats little above the marshes now liable to floods. With these are associated sheets of loam or brickearth, probably of contemporaneous origin. Palæolithic implements occur in these gravels; but it is not clear whether they are contemporaneous or were derived from the older and higher gravel.

Though the valley gravels occupy a considerable area, not much need be said about them. They are very uniform in character throughout the district, and being derived mainly from the older series their composition is very similar. The principal differences are, that they are more stratified, are usually cleaner and that they contain a noticeable admixture of unworn or broken flints, derived immediately from the Chalk area to the north, and not indirectly through other gravels.

If we commence with the gravels bordering Southampton Water we notice a well-defined terrace extending about three miles from Hamble to Netley. The gravel is usually about 10 feet thick at its lower edge, but in one of the wells at Netley Hospital it is as much as 16 feet. Its upper edge rises to 40 feet above mean tide. On the opposite side of Southampton Water a slightly lower terrace occurs at Hythe, and similar low terraces underlie the lower part of Southampton, including Northam, St. Denys, and Bitterne. At Swaythling and Eastleigh this gravel spreads out into a wide flat averaging a mile and a half across, and is overlaid by thin loam, which has been dug for brickmaking. This sheet is so level that its upper edge is only about 15 feet above the marsh.

The gravel in the Test Valley makes a wide spread, but does not call for particular description, as its distribution is clearly shown on the Map. It is noticeable, however, that a second terrace, a few feet above the lower one, is preserved near Nursling, and seems to be continued by gravels at about the same level between Eling and Marchwood.

Thin sheets of gravel out of the main valleys, like the sheets of Highland Water, Blackwater, and Cadnam, are more sandy and less stratified—in fact, they resemble more closely rainwash from the dominating gravel plateaus than clean river-gravels. They call for no other remark.

ALLUVIAL DEPOSITS.

The alluvial deposits of Southampton Water fill up a valley descending considerably below the present sea-level, and even below the bottom of the existing estuary. At the beginning of the period when these deposits were laid down the land stood at least forty feet above its present level, so that Southampton Water was then nothing but a non-tidal river running in a

narrow channel bordered by lowlands and marshes, which are now represented by the "submerged forests," and beds of peat or shell-marl, only to be seen in dock-excavations that descend beneath the sea-level. At the base of this ancient Alluvium gravel is usually found, and in this gravel occur bones, including those of the reindeer. The general section at Southampton Docks is as follows, though the thickness varies considerably at different points, and the greatest depth of the old channel has not yet been proved:—

	Feet.
Estuarine silt	20
Peat, old vegetable soil, or tufaceous marl; ox, pig, horse, pine, beech, birch, oak, and hazel	variable, -J up to 17.
Gravel, with reindeer	10 or more.

The gravel lies at so low a level that it cannot often be seen. An antler of reindeer, now in Southampton Museum, is labelled "top of gravel under the peat at the entrance to the Empress Dock, 35 feet below the mud." The mammoth also probably occurs in this gravel, for a tooth, also in the Southampton Museum, is labelled as "dredged from the ballast hole at Weston, near Southampton, at a depth of about 12 feet below surface of gravel."

Mr. T. W. Shore has recorded* from the peat above the gravel a fine stone hammer head of Neolithic date and worked articles of bone, but thus far no instruments made of metal have been found. This seems to indicate that the lowest "submerged forest" belonged to the Neolithic period. The peat and associated marl have also yielded bones of *Bos primigenius*, red deer, pig, and hare, with wood of oak, beech, pine, and birch, all of which are in the Southampton Museum. Mr. Whitaker sent me in 1888 a sample of the peaty bed from this dock. I found that it had apparently formed an old soil, for the nuts in it were very much decayed and apparently penetrated by roots. The only determinable plants were *Ranunculus*? (buttercup), *Rubus* (blackberry or raspberry—a fragment of a stone nipped by a bird), *Sambucus nigra* (elder), *Corylus Avellana* (hazel), *Scirpus maritimus*?, and two other undetermined sedges. It is noticeable that both plants and animals are living forms, and indicate a climate not greatly differing from that now found in Hampshire. It is not clear whether the reindeer and the mammoth of the underlying gravel point to less genial conditions, for at present no other fossils have been found in that deposit. Mr. Whitaker describes the marl as generally full of freshwater shells (*Limnæa*, &c.), and containing small roundish tufaceous nodules, like the marl that occurs at the surface in the alluvium of the Itchen. Other particulars will be found in the paper by Messrs. Shore and Elwes.†

* "Hampshire Mudlands and other Alluviums." *Proc. Hants Field Club*, pp. 181-200 (1893).

† *Proc. Hants Field Club*, No. 111, pp. 43-50 (1889)

The following notes by Mr. Whitaker (in small type) describe the sections seen in the Empress Dock during its excavations in 1887-9 :—

1887, Sept. 5th. Along N. side of dock, from near W. end.

There was a long shallow hollow in the gravel, filled with peat and then with marsh clay. Some rootlets in the high part.

At east side of hollow green sand (Bracklesham Beds) was touched below the gravel, which rises up and is about 5 to 7 feet thick in parts.

Later (Oct. 14th).

On N. side of hollow the alluvium sometimes rested on the Bracklesham Beds, the gravel having been eroded.

The green sand was mixed with loam, and lower down there was grey sandy clay, which was generally separated from the green sand by a little light-coloured sand. The section at one place was as follows :—

Alluvium and gravel.

Bracklesham Beds.	{	Pale greenish clayey sand, about 4 feet.
		Light-coloured and brown sand, about 1½ feet.
		Grey clayey sand, passing soon into sandy clay.

The division between the alluvium and the gravel was even for some way, and then fell somewhat (eastward), when lenticular patches of whitish shell-marl came in, below the thin peat. At one small patch rootlets occurred in the top of the marl, and below the marl was sandy clay, about 3 feet thick, resting on the gravel.

Some of the patches of marl, and of some length, were *in* the peat or peaty earth.

The marsh-clay, above the peat, contains sea-shells. The peat, with its rootlets, points to a land surface. The shell-marl must have been deposited in fresh water, under different conditions from those now holding (as also is the case with the marsh-clay, the latest deposit). This alternation of beds deposited under different circumstances is interesting.

October 14th. S.W. part (?).

There were lenticular masses of shell-marl in the peat, and the marine clay was close above.

Near by, at the face, there was no marl, but below the peat, clayey sand, greenish at the base, came in, varying in thickness from 0 to 2 feet, and along the then face, towards the town, there was this silty base to the Alluvium, and sometimes only a trace of peat. Then gravel rose up, and the greenish sand of the Bracklesham Beds came up high.

December 1st.

At E. part the peat had sand next beneath. This was at one part buff and impure, but in some parts greenish-grey (? from dampness). There was one large lenticular patch of marl at top of the peat.

Further S. the peat was sometimes thick, and its thickening was irregular. The foreman said that a boring had passed through as much as 17 feet. I saw 6 feet.

At one place rootlets reached into the clayey sand below the peat to the depth of about 2 feet. There were also rootlets in the shell-marl, where little peat was above it.

Towards the S.E. corner, and near the middle of the excavation, the greenish clayey sand and the peat dropped sharply eastward, and then the marl followed. Then the peat rose, and partly went over the marl. Then the marl rose up from beneath the peat for awhile. Near the S. edge the gravel was fairly thick? (10 feet or more), and not bottomed.

1888. January. N.W. end.

Gravel came up high, with only clay above and close by, eastward, the Bracklesham Beds came high up.

Over 6 feet of marl or tufa was seen at one place, near the eastern side.

February 1st.

Near S. point, S.W. side (entrance), peat rested direct on gravel, which latter was then greenish for about 3 feet down.

Toward the entrance the peat sloped down pretty sharply. (? An old channel of Itchen nearly along E. side. Also in one of graving docks, N. See A. Giles, *Proc. Inst. Civ. Eng.*, vol. xcii. p. 168. 1888.)

Further from the entrance, beyond the middle of face, there were some small lenticular patches of peat in clay, a foot or more above the main peat.

March 21st. Central part, towards E. side.

Near the side peat, &c., were deep. Westward the gravel rose up sharply, sometimes at an angle of nearly 20°, for 12 feet or more.

N. side. Bracklesham Beds shown as follows :—

Green-grey sand, with a few flint-pebbles at the base, for a length of about 2 feet (the first pebbles seen here in this formation) ; nearly 3 feet.

Brownish and light-coloured sand, with thin layers of clay ; ferruginous at the base ; about 1½ feet. This bed at one place only.

Grey sandy clay, passing down into the next.

Grey clay, laminated by layers of sand ; thick (to base).

N. part of W. side. Where the Bracklesham Sand comes up high (N.). The brownish sand was seen to have a system of joints, roughly eastward and westward, with a thin coating of grey matter down them.

Further S. there was a long thin layer of green sand in the thick gravel.

June 7th. Old channel a little way from and parallel to E. face. (Referred to above.)

Peat, with thin layers of marl or marly clay. At base pale-grey, rather clayey sand, or silt, with vegetable remains (rootlets, nuts), which seemed to pass down (where deeper, southward) into sand.

This runs to the main channel at right angles. Along this E., a little way before getting to old head-wall of what was the "Dock Extension Pier," the gravel rises up ; also at the wall.

October 9th. New ditch (N.) near middle of S. wall.

Green-grey sand of Bracklesham Beds, with shells (*Cardita planicosta*. *Ostrea*?, *Oliva*?, *Voluta*).

The same by S. wall, opposite, and along wall.

The gravel had been taken off, showing small irregular channels in the Bracklesham Beds.

In the central part some of the gravel showed current-bedding, in a northerly direction.

There was a big greywether, apparently from the gravel.

1889. April 23rd.

Near middle, toward W. Bracklesham Beds shown. At bottom light; coloured (whitish) sand, finely but irregularly bedded, with thin irregular broken layers of lignite along many of the bedding-planes.

Just E. this is overlain by dark grey clay.

In March Mr. T. W. Shore showed me specimens from the northern side, where the slip occurred and where the excavation was carried down deeper ; 12 feet below the base of the former wall (which fell) there was green clay, and 3 feet lower, at the bottom, there was brownish-grey clay.

At Nursling remains of beaver have been found. There are no particulars as to the deposit from which the specimen in the Hartley Museum was obtained, and it was probably found in the newer Alluvium. Further particulars of the depth and character of the Alluvium will be found among the borings at the end of this Memoir.

SHELL-MARL.

Tufaceous shell-marl connected with the Alluvium of the Test and Itchen was formerly dug under the name "malm," and used for improving the land. Sections just outside our district north of Romsey were described by Lyell as long ago as 1825, and other deposits of somewhat older date around Southampton have since been recorded by Messrs. Shore and Elwes, and by Mr. Kemp.* The marls, though somewhat tufaceous and concretionary, are composed in the main of freshwater shells mingled with decayed stems and fruits of *Chara*.

PEAT.

Peat-bogs form a characteristic feature of the New Forest over areas of waterlogged sand, but not elsewhere. Matley Bog and Denny Bog, east of Lyndhurst, are good examples of these bogs, for they become impassable, and cattle are lost in them after rain. The New Forest peat-bogs are largely composed of bog-myrtle, creeping-willow, and cross-leaved heath, mixed with sedges and rushes. Moss forms only locally any considerable part of the bulk. No great use is made of this peat, pared turves or wood being more generally used for fuel. There is nothing to indicate that these bogs change much from century to century; one can find places where the peat is crumbling away and disappearing; but, on the other hand, certain parts are spreading. The relations of the bogs to old roads or crossing places does not suggest any noticeable change.

* "The Tufaceous Deposits of the Test and Itchen." *Proc Hants Field Club*, No. III., p. 83 (1889).

CHAPTER XI.—ECONOMIC GEOLOGY.

BUILDING MATERIALS.

With the exception of a little ferruginous sandstone found in the Bagshot or Reading Beds, brick is the sole building material within the district. The strata which yield the brickearth are so extremely variable, the earth itself so commonly occurs in lenticular masses of limited extent, and so much depends on the amount of weathering, that it is only possible to indicate in a general way where good brickearth will be found.

Over the areas coloured Chalk on the map there is no brick-earth, the overlying thin drift being here very sandy. In the Reading Beds brickearth occasionally occurs in lenticular masses of small extent; though it is more usual to find in this series either coarse sand, or else plastic clay, more fit for tiles and pipes than for bricks. Throughout the area we are now describing the Reading Beds are usually very sandy. The London Clay yields good brickearth if well weathered; it is here sufficiently sandy, as a general rule, to need no mixture of sand. The top and bottom are more sandy than the middle. The most extensive brickyards in the district are opened in the Bracklesham Beds, especially towards their base. This stratum is normally a shelly glauconitic green marly loam full of pyrites. In its unweathered condition it is probably quite useless; but on the hills and steep slopes, where rain has penetrated freely, it becomes a brown loam of fair quality and easy to work. The bricks used in Southampton are principally made from this lower part of the Bracklesham Series. The Barton Clay is a good deal stiffer and more suitable for tiles; good loam, however, will probably be found where this clay passes into the Barton Sand. The Headon Beds, like the Bracklesham Series, are extremely variable; around Lyndhurst they are generally too shelly and marly for good brickearth. A small amount of brickearth is to be found in places over the Valley Gravel. Brickearth of this period is usually good and free from lime; it is, however, only found in any quantity around Eastleigh, where it is largely used, though but thin.

Most of the shallow irregular excavations scattered over the district were made to obtain the mixture of mud and stones anciently used for building "dob" walls. This art is now nearly extinct. It may save waste of money to point out that the overgrown pits do not indicate places where either clean brick-earth or clean gravel can be dug. Good dob is a puddled and weathered mixture, such as is not used for anything else, unless it be for puddling the bottoms of ponds or canals.

ROAD METAL.

Flint-gravel is the common material used for roads in this district. It is derived from several sources, and varies much in quality. The Eocene pebble-beds, though often used, are really not fit for road metal. The flint-pebbles usually average about two inches in diameter and are perfectly smooth; they are consequently too small to be broken and too smooth to bind properly, even when mixed with marl, which is only occasionally obtainable. The value of the Plateau and Valley Gravels for road metal depends largely on the proportion of pebbles they contain; where the metal is rough and angular, as it usually is towards the northern part of our area, good road metal can be obtained. In the southern area, however, the gravel is usually full of pebbles, and no attempt is made to get rid of these. The best road-metal consists of the large flints picked off the fields and then broken. These are tougher than those obtained from the Chalk, for not only does exposure to the weather tend to anneal them, but they have undergone a process of natural selection, all the flawed pieces having been split up by the frost, so that only the sounder ones are left.

WATER SUPPLY.

Southampton is supplied with excellent water from the Chalk at Otterbourne, and from similar sources outside the district. The Otterbourne water is somewhat hard when pumped, and is softened before using from 18 degrees to 7 degrees. The amount pumped is about 3,000,000 gallons per day. Up to about ten years ago water was obtained from the Itchen, which was liable to contamination; the deep well on Southampton Common, which cost upwards of £20,000, was a failure, its greatest yield having been only 130,000 gallons per day.

The water from the various Tertiary sands, which is used in other parts of our area, contains less lime, but is usually ferruginous, especially in the Barton Sand. The fine grain of the sands, except in the Reading Beds, and the constant occurrence of loamy seams, make it difficult to obtain large supplies from this source, though moderate amounts can usually be found within a reasonable depth, except in the London or Barton Clays. The Plateau Gravel contains a good deal of water; but this superficial source runs nearly dry after drought, and the water is very liable to contamination.

APPENDIX.

WELL SECTIONS AND BORINGS.*

BRAMSHAW.—Mr. Eyre's Estate. By pond S. of Bramshaw Hill. [w]

		Thickness. Feet.	Depth. Feet.
Soil		1	1
[Bracklesham Beds]	Clay	3	4
	Dense grey sandy loam	7	11
	Wet sand, with a six inch band of iron- stone full of good water	9	20
	Very hard sand, in parts nearly black with vegetable matter. No water	3	23
	Greenish sand crust	$\frac{1}{2}$	23 $\frac{1}{2}$
	Soft sand	4	27 $\frac{1}{2}$
	Crust, as above, but harder	$\frac{3}{4}$	28
	Sand	3	31
	Dingy blue clay reached	—	—

DIBDEN.—Windmill House. A little south-westward of Langdown
Windmill, and southward of Baker's Farm. 1892. [w]

About 106 feet above Ordnance datum. Made and communicated
by Messrs. A. Williams and Co. [and from specimens]. Shaft 13 feet,
the rest bored. Unsuccessful. Before getting through the rock, at
445 feet, the water-level was 172 feet down. Later on it rose slightly, to
160 and then to 150.

		Thickness. Feet.	Depth. Feet.
[Drift]	Gravel	19	19
	Gravel and sand	5	24
[Barton Sand, 72 feet]	Sand [at 44 feet, fine buff sand, with some bits of greenish-grey sand]. Water at 44 feet	33	57
	Running sand	5	62
	Blue sand, a little water, exhausted by four hours pumping at the rate of 300 gallons an hour (brackish and of bad smell)	34	96
	Blue sandy clay	10	106
	Blue clay [some greenish-grey clay, with bits of shell. Stiff grey clay, with bits of shell at 138 feet. The like at 154, but a trifle sandy]	81	187
	Sandy clay	21	208
	Black sand [specimen of greenish sandy clay or clayey sand]	6	214
	Green loamy clay and black sand	12	226
	Dark green sand	2	228
	Dark green loamy clay [at 347 grey clay, with a few small bits of shell. At 350 grey and slightly greenish- grey clay and sandy clay. At 390- 400 grey slightly sandy clay, with broken shells and some green sand. At 444 brownish-grey clay with bits of shells. Hard sandstone at the bottom 5 feet]	217	445

* Many of these, marked [w], have already been published by Mr. Whitaker in the *Proceedings of the Hampshire Field Club* for 1889 and 1898. Engineers' trial-borings (not for water) have been placed at the end of the Appendix.

DIBDEN.—Windmill House—*cont.*

		Thickness. Feet.	Depth. Feet.
[Barton or Bracklesham Beds]	{ Light green loamy clay [greenish sand slightly clayey, with broken shell, top 10 feet]	25	... 470
	{ Light green loamy clay with rock	4	.. 474
	{ Dark green loamy clay	26	... 500

There is an older well at Langdown Hill about 45 feet deep, with the water-level about 39 feet down, which was the same as in the above boring in June 1891. This water is also slightly brackish, and with a disagreeable smell and taste.

I should differ in referring all strata below 208 feet in the Dibden Well to the Bracklesham Series. (C.R.)

ELING.—Langley Manor, Hunter's Hill. 1887. [w]

Bored and communicated by Messrs. Isler [and from specimens].

Water-level 80 feet down. Yield 300 gallons an hour.

		Thickness. Feet.	Depth. Feet.
[Barton and Bracklesham Beds]	Old dug well	—	... 28
	Clay	7	... 35
	Blue sandy marl [specimen of grey clay, with greenish sand]	39	... 74
	Stiff blue clay	8	... 82
	Sandy blue clay	4	... 86
	Stiff clay	12	... 98
	Sandy marl [specimens of green-grey clayey sand or sandy clay]	27	... 125
	Stone [specimen of hard calcareous clay]	1	... 126
	Sand [specimens of green-grey clayey sand or sandy clay, with bits of shell at 136 and 148: then specimen of green-grey clay]	31	... 157
	Sandy clay	1	... 158
	Sand	7	... 165
	Stiff sandy clay [specimens of fine greenish-grey clayey sand at 178; of green sandy clay at 200; and of dull brownish clay with a little greenish sand at 205]	40	... 205
	Stiff clay	6	... 211
	Stiff sandy clay	23	... 234
	Stiff green sand [specimen of hard brown rather sandy clay at 245; of brownish and greenish clayey sand, with remains of shell, at 247; and of greenish-grey firm clayey sand at 248]	76	... 310

Perhaps we should refer the uppermost 35 feet of strata in this well to the Barton Clay, the rest belonging to the Bracklesham Series. (C.R.)

HYTHE.—Winterton Hall, N.W. of house (in field). 1885. [w]

Communicated by Mr. G. F. Giles, and from specimens.

Field overflowed by high water spring tides (reclaimed land?).

Water, from the last bed but one, rises to the top of the bore-pipe, and cannot be lowered more than 40 feet.

		Thickness. Feet.	Depth. Feet.
[Alluvium.]	- Yellow clay - - - - -	8 ...	8
[Drift.]	- Yellow gravel, very compact . -	10 ...	18
	Blue clay. [Specimens of grey clay, rather sandy.] -	17 ...	35
	Sandy blue clay } [Specimens of rather	2 ...	37
	Green sand } sandy grey clay.] {	1 ...	38
	Blue clay. [Specimens, 39-41, grey sandy clay.] -	2 ...	40
	Green sand; great quantity of water. [Specimens, 42-44, fine grey clayey sand.] -	4 ...	44
	Blue clay - - - - -	3 ...	47
	Blue clay with sand - - - - -	3 ...	50
	Blue clay - - - - -	1 ...	51
	Blue clay with sand - - - - -	2 ...	53
	Green sand - - - - -	3 ...	56
	Blue clay with sand - - - - -	11 ...	67
	Blue clay with much sand - - - - -	? 1½ ...	68½
	Blue clay with sand - - - - -	9 ...	77½
	Green sand. [Specimens of fine clayey sand] - - - - -	2 ...	79½
	Blue clay with sand. [Specimens, 80-85, 87, 88, grey sandy clay; 86, 89-91, grey clayey sand] - - -	? 11½ ...	91
	Hard blue clay. [Specimens 92, 93, grey sandy clay; 94 grey clayey sand; 95 green-grey sand] - - -	4 ...	95
	Hard blue clay. [Specimens of grey clay] - - - - -	6 ...	101
[Barton Beds and Bracklesham Beds.]	Hard blue clay with sand. [Specimens of grey, partly greenish, clay, some rather green] - - - - -	22 ...	123
	Hard blue clay. [Specimens of grey clay, some slightly sandy, some slightly greenish] - - - - -	19 ...	142
	Hard blue clay with sand. [Specimens grey clay] - - - - -	3 ...	145
	Blue sandy clay - - - - -	1 ...	146
	Blue sand with very little clay } [Specimens, grey and greenish sandy clay.] {	3 ...	149
	Blue sand with more clay. Specimen brownish - - - - -	1 ...	150
	Hard blue clay, very little sand - - - - -	3 ...	153
	Hard blue clay with sand - - - - -	3 ...	156
	Hard blue clay, less sand and with a mass of stone - - - - -	1 ...	157
	Hard blue clay - - - - -	2 ...	159
	Hard blue clay with a few small pieces of shell [Specimens of greenish-grey and brownish clay, some sandy] - - - - -	9 ...	168
	Very hard brownish clay, with a few shells - - - - -	6 ...	174
	Green sandy clay - - - - -	2 ...	176
	Brown mottled clay, with a few small shells - - - - -	4 ...	180

HYTHE.—Winterton Hall—*cont.*

		Thickness. Feet.	Depth. Feet.
[Barton Beds and Bracklesham Beds— <i>cont.</i>]	Green sand with streaks of clay, and a few small shells	[Specimens of brownish with green sand at 183.]	4 ... 184
	Blue sandy clay		1 .. 185
	Hard brownish-blue clay.	[Specimens of brownish and slightly greenish sandy clay]	3 ... 188
	Green sandy clay, with fragments of shells.	[Specimens greenish grey]	2 ... 190
	Very hard blue clay, with a little sand, and fragments of shells.	[Specimens of greenish-grey sandy clay, at 191, 192, 193]	3 ... 193
	Green sandy clay		5 ... 198
	Green sand, with a large quantity of fresh water		3 ... 201
	Green sand, with more clay		1 ... 202

It is hard to make a division between the Barton Beds and the Bracklesham Beds.

LYNDHURST.

Boring communicated by Messrs. A. Williams and Co. [w]

Water-level 6 feet down. Yield 900 gallons an hour.

		Thickness. Feet.	Depth. Feet.
[Barton Sand]	Live yellow sand	21 ...	21
	Dead sand	4 ...	25
	Live sand	4 ...	29
	Blue dead sand	22 ...	51
	Dead sand and shells	38 ...	89
[Barton Clay]	Dead sand	7 ...	96
	Sandy blue clay	5 ...	101
	Brown clay and shells	4 ...	105
	Blue clay and shells	14 ...	119
	Blue clay and sandstone	6 ...	125

NETLEY.—Royal Victoria Hospital. [w]

Sections from A. Beamish, Lieut. R.E., dated 1867 (and 1869?), with further information from Major Nixon, R.E. (1886).

1. NORTH WING.

Shaft 40 feet, the rest bored. Water level 16 feet down. (Figures in brackets from another account, by Major R. Bullen, R.E.)

		Thickness. Ft. In.	Depth. Ft. In.
Gravel		1 to 16	6 ... 16 6
		37	2 ... 53 8
[Bracklesham Beds.]	Hardened sand (29)	1	9 ... 55 5
	Mottled sandy clay (11ft. 9in.)	1	0 ... 56 5
	Hard clay	27	0 ... 83 5
	Greenish-yellow sand	6	0 ... 89 5
	Light-coloured clay	11	0 ... 100 5
	Light-grey clay	5	0 ... 105 5
	Hard clay	11	0 ... 116 5
	Sand and clay, with fossils	9	0 ... 125 5
	Coarse grit sand	6	0 ... 131 5
	Fine running sand	7	6 ... 138 11
	Dark chocolate [coloured] sand	11	1 ... 150 0
	Grey sand, full of shells (11)	10	0 ... 160 0
	Mottled sand, with clay and shells (9)	20	0 ... 180 0
	Dark green sand, mixed with clay (21 ft. 1 in.)		

NETLEY—Royal Victoria Hospital—*cont.*

2. SOUTH WING (850 feet from the above).

Shaft 37 feet, the rest bored. Water-level 16 feet down.

	Thickness. Feet.	Depth. Feet.
[Bracklesham Beds.] { Brickearth - - - - -	0½ ...	0½
Green sand - - - - -	5 ...	5½
Hard clay - - - - -	1 ...	6½
Green clay and small shells - - -	2½ ...	9
Dark brown clay - - - - -	4 ...	13
Rather stiff green clay and large shells	9 ...	22
Green clay, with fossils ? - - -	6 ...	28
Greenish sand - - - - -	89 ...	117
Stiff clay, with bed of white sand	12 ...	129
Stiff clay - - - - -	12 ...	141
Very stiff clay - - - - -	20 ...	161
Green sand - - - - -	15 ...	176

3. LAUNDRY WELL.

Shaft 45 feet, the rest bored. Water-level 14 feet down.

	Thickness. Feet.	Depth. Feet.
Not observed - - - - -	— ...	60
[Bracklesham Beds.] { Sand - - - - -	20 ...	80
Stiff grey clay, with pieces of black turf material - - - - -	9 ...	89
Dark greyish or greenish slightly loamy sand - - - - -	36 ...	125
Dark-green sand - - - - -	21 ...	146
Dark-grey sand, with shelly particles	4 ...	150
Light-grey and greenish sand - - -	10 ...	160
Grey mottled clay - - - - -	7 ...	167
Chocolate [coloured] loamy sand - -	3 ...	170
Black turfy soil - - - - -	2½ ...	172½
Coarse light-grey crystalline sand -	9½ ...	182
Stiff clay - - - - -	5 ...	187
Chocolate [coloured] loamy sand - -	3 ...	190
Fine yellow quicksand - - - - -	3 ...	193
Black turfy soil - - - - -	3½ ...	196½
Dark-grey sand - - - - -	4½ ...	201
Dark loamy sand - - - - -	1 ...	202
Clay - - - - -	4½ ...	206½
Black turfy soil - - - - -	1 ...	207½
Dark stiff clay - - - - -	3½ ...	211
Stiff blue clay - - - - -	8 ...	219
Mottled clay - - - - -	18 ...	237
Greenish sand - - - - -	15 ...	252
Hardened sand - - - - -	1 ...	253
Light-greenish sand - - - - -	4 ...	257
Light-brown and grey stiff clay - -	16 ...	273
Grey sand - - - - -	2 ...	275
Stiff clay - - - - -	1½ ...	276½
Light-green sand, with pieces of hardened yellow sand - - - - -	13½ ...	290
Stiff light-blue clay - - - - -	20 ...	310
Hard black clay - - - - -	1 ...	311
Stiff dark clay - - - - -	9 ...	320
[Lower Bagshot Beds.] { Black [flint] pebbles - - - - -	8 ...	328
Light-green sand - - - - -	3 ...	331

NORTH STONEHAM.—Red Lodge. [w]

Communicated by Mr. W. E. Darwin.

	Thickness. Feet.	Depth. Feet.
Gravel ... - - - - -	11 ...	11
[Bracklesham Beds.] { Sand - - - - -	3 ...	14
White clay - - - - -	4 ...	18
White sand - - - - -	8 ...	26
Brown clay - - - - -	15 ...	41
Black clay - - - - -	9 ...	50
Brown Sand - - - - -	9 ...	59
Black clay or mud (offensive) - - -	4 ...	63

NORTH STONEHAM.—Red Lodge Nursery; close to the house. [w]

From a drawing in the possession of the Corporation of Southampton.
230 feet above high-water level.

	Thickness. Feet.	Depth. Feet.
Shaft, the rest bored	(about) —	50
Yellow sand	10	60
Blue clay	26	86
Black sand and clay	20	106

SARISBURY.—In Winnard's Copse, Holly Hill, 1898.

From notes and samples communicated by Messrs. Dunn and Booth.
Surface about 102 feet above Ordnance Datum. Water level 78 feet down.
Sand flows in and chokes the bore.

	Thickness. Feet.	Depth. Feet.
Drift.	1½ ...	1½
{ Mould	2½ ...	4
{ Earthy gravel	2 ...	6
{ Mottled red and grey clay	3 ...	9
{ White clay	2½ ...	11½
{ Orange sandy clay	6½ ...	18
{ Green sand	5½ ...	23½
{ Dark green sand	3½ ...	27
{ Dark green loamy sand	6 ...	33
{ Mixed sand and clay, green	2½ ...	35½
{ Dark blue-green sandy clay	17½ ...	53
Bracklesham	2½ ...	55½
{ Grey loamy sand	2½ ...	58
{ Dark grey clay and sand	13 ...	71
{ Grey sand	5 ...	76
{ Brown clay	7½ ...	83½
{ Brown and white mottled clay	10½ ...	94
{ Black carbonaceous clay	30½ ...	124½
{ Dark grey clay with vegetable matter	17½ ...	142
{ Dark grey loamy sand	19 ...	161
{ Hard black and grey loam		
{ Green loamy sand (glauconitic)		
Bagshot		
{ Green sand (no glauconite) pyrites at		
{ base	18½ ...	179½
Sands.	1 ...	180½
{ Brown sandy clay		

No fossils were observed, and the division between Bracklesham and Bagshot is not clear. The strata below 53 feet resemble the lowest and sparingly fossiliferous part of the Bracklesham Series in Sussex.

SOUTHAMPTON.—The Common. For supply of the Town.

Communicated by Mr T Doewra and Messrs. Easton and Amos.

Shaft to 560 feet; rest 6" bore.

Greatest yield only 130,000 gallons per day.

	Thickness. Ft. In.	Depth. Ft. In.
Vegetable soil	2 0 ...	2 0
Sand and water	6 0 ...	8 0
Sand	2 6 ...	10 6
Sandy clay	1 6 ...	12 0
Sand, watery	3 6 ...	15 6
Clay	5 0 ...	20 6
[Bracklesham	3 6 ...	24 0
{ Sandy clay with water	4 0 ...	28 0
{ Crust of hard indurated sand	3 0 ...	31 0
{ Clay with pyrites	2 0 ...	33 0
{ Sandy clay	6 0 ...	39 0
{ Sand, coloured clay, and wood	3 0 ...	42 0
{ Hard clay		
{ Sand		
{ Stiff clay with veins of sand and much		
{ water	2 6 ...	45 0

SOUTHAMPTON.—The Common—*cont.*

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
[Bagshot Sands.]	Sharp sand with pebbles and petrified wood -	7	0 ...	52	9
	Sandy clay -	23	0 ...	75	9
	Running sand, very watery -	1	0 ...	76	9
	Sand with pebbles -	1	0 ...	77	9
	Dry sand with shells -	1	9 ...	79	6
	Sand -	4	0 ...	83	6
	Hard dead sand, full of pebbles and shells -	1	0 ...	84	6
	Do. with pieces of wood -	1	0 ...	85	6
	Hard stone, with water, shells, and pebbles -	1	0 ...	87	0
	Dead sand, full of shells, vein of sand very watery -	1	9 ...	88	9
	Dead sand with pebbles -	1	9 ...	90	6
	Dead sand -	12	0 ...	102	0
	Sandy clay and shells -	6	6 ...	109	0
	Vein of hard jointed clay, rather watery } Do. rather sandy }	8	0 ...	117	0
	Very hard dead sand, full of shells and pebbles -	1	8 ...	—	—
	Very hard stone, full of pebbles, shells, water -	6	0 ...	124	6
	Very sandy clay, with shells, wood, and petrifications -	9	0 ...	133	9
	Stiff clay, rather sandy, vein of sand watery -	2	0 ...	—	—
	Stiff clay, rather sandy, with shells -	3	0 ...	138	9
	Clay with more sand, shells, and pebbles -	8	0 ...	—	—
	Hard dead sand and shells -	1	0 ...	148	0
	Layer of stone with water -	8	0 ...	156	0
[London Clay.]	Dead sand with numerous shells -	1	6 ...	—	—
	Layer of stone -	3	6 ...	161	0
	Dead sand with numerous shells -	6	0 ...	—	—
	Layer of stone with shells embedded -	—	—	167	6
	Spring of water -	3	0 ...	170	6
	Layer of stone with shells embedded -	4	0 ...	174	6
	Large stone projecting on one side -	9	0 ...	184	0
	Sandy clay, layer of pebbles at base -	36	0 ...	220	0
	Sandy clay with a variety of shells -	1	0 ...	221	0
	Petrified wood -	17	6 ...	238	6
	Sandy clay with a large variety of shells -	6	0 ...	244	6
	Clay with numerous shells -	1	0 ...	245	6
	Layer of stone -	33	0 ...	278	6
	Clay with numerous shells -	3	0 ...	281	6
	Hard clay with shells -	6	0 ...	287	6
	Clay with shells -	1	0 ...	288	6
	Layer of stone -	13	6 ...	302	0
	Clay with shells -	2	0 ...	304	6
	Sand with pebbles -	3	6 ...	308	0
	Sand watery -	1	0 ...	—	—
	Dead sand -	2	0 ...	—	—
	Running sand, very watery -	8	9 ...	319	3
	Clay, rather sandy, with shells -	1	6 ...	—	—
	Layer of stone -	24	3 ...	348	0
[Reading Beds.]	Clay, rather sandy, with shells -	2	3 ...	—	—
	Three layers of stone -	5	0 ...	—	—
	Clay rather sandy -	1	0 ...	—	—
	Pieces of petrified wood -	4	0 ...	—	—
	Sandy clay -	1	3 ...	358	6
	Layer of hard sand -	13	0 ...	371	6
	Sandy clay -	72	0 ...	443	6
	Plastic clay -	6	0 ...	450	6
	Do. with chalk [race?] -	1	0 ...	—	—
	Green sand with veins of clay -	2	0 ...	—	—
	Do. with pebbles -	1	6 ...	454	6
	Do. flints and chalk -	—	—	—	—

SOUTHAMPTON.—The Common—*cont.*

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
[Upper Chalk.]	{ Chalk with flints	812	0 ...	1,266	6
	{ Do.	3	6 ...	1,270	0
	{ Do. and of a brown colour	19	0 ...	1,289	0
[Middle Chalk.]	{ Do. with flint, light and very free	1	6 ...	1,290	6
	{ Do. blue and cloggy	14	9 ...	1,305	0
	{ Do. dark blue with flints and sponges	2	0 ...	1,307	0
	{ Do. do. with veins of clay	2	0 ...	1,309	0
	{ Do. do. very cloggy	4	6 ...	1,313	6

Another version of this well, down to 1,260 feet, from a section drawn by E. Drew, September 1850, differs in various particulars.

		Ft. In.		Ft. In.	
		Ft.	In.	Ft.	In.
Vegetable soil	-	8	6 ...	8	6
Light sand with water	-				
Yellowish-brown sand	-				
[Undescribed]		2	0 ...	10	6
Orange-coloured sand with clay		1	6 ...	12	0
Orange sand with water		2	0 ...	14	0
[Undescribed]		1	0 ...	15	0
Black clay		5	0 ...	20	0
Yellow and orange-coloured sand with clay		10	0 ...	30	0
Slate-coloured sand		2	0 ...	32	0
Greenish sand with lime water		10	0 ...	42	0
Black clay with brown sand		6	0 ...	48	0
Clay and sand full of round pebbles		18	0 ...	66	0
Light-brown sand and water		2	0 ...	68	0
Dry brown sand		5	0 ...	73	0
Hard brown sandstone		2	0 ...	75	0
Slate-coloured sand with broken shells (stratum of shelly sandstone 18 inches thick)		3	0 ...	78	0
Nodules of septaria					
Blue clay with sand and broken shells <i>Dentalia</i> , <i>Turbo</i> , <i>Pleurotoma rotata</i> , <i>Ostrea</i> , <i>Fusus</i> , <i>Ros-tellaria</i> , <i>Buccinum prismaticum</i> , <i>Pleurotoma vulpecula</i> , <i>Solarium variegatum</i> , <i>Cythera</i>		48	0 ...	126	0
Sand with black rounded pebbles, very smooth (2 beds)		2	0 ...	128	0
		3	0 ...	131	0
Blue clay (?) with sharks' teeth, <i>Dentalia</i> , <i>Nautili</i> , septaria, carbonised wood pierced by <i>Teredines</i> . Greenish sand in the soil		8	0 ...	139	0
Brown dry sand with broken shells		2	0 ...	141	0
Blue clay (?). A Nautilus filled with pyrites		12	0 ...	153	0
Bed of numerous rounded black pebbles and sand. Shells, some filled with pyrites		5	0 ...	158	0
Dark brown sand		26	0 ...	184	0
Brown clay with numerous shells		7	0 ...	191	0
Clay (?). Masses of pyrites with broken shells, septaria, carbonised wood, <i>Pleurotoma denti-cula</i> , <i>P. tuberculosa</i>		31	0 ...	222	0
Masses of septaria full of shells and very hard carbonised wood		2	0 ...	224	0
Blue and slate-coloured clay, with masses of septaria, pyrites, and broken shells		75	0 ...	299	0
Masses of limestone with shells. Fragments of carbonised wood and pyrites		3	0 ...	302	0
Blue clay with much sand		10	0 ...	312	0
Septaria, carbonised wood with pyrites [in blue clay ?]		13	0 ...	325	0
Dark blue clay		57	0 ...	382	0
[Reading Beds.] { Coloured [red-mottled clays]		100	0 ...	482	0
		1	0 ...	483	0
Upper Chalk } Soft Chalk with flints		770	0 ...	1,260	0

SOUTHAMPTON.—Railway Terminus (Docks). 1840.

Mr. T. W. Shore, in *Rep. Brit. Assoc.* for 1883, p. 152.

Shaft 64 feet, rest bored.

		Thickness. Feet.	Depth. Feet.
[Made ground and Drift.]	New-made soil of mud with shingly gravel	8 ...	8
	Whitish clay and stones	2 ...	10
	Whitish clay	5 ...	15
	Gravel with clay		
	Yellow gravel		
[Bracklesham Beds.]	Green sand with water	5 ...	20
	Blue sand with <i>Venericardia</i> and <i>Turritella</i>	10 ...	30
	Blue sand like indigo	5 ...	35
	Blue sand	5 ...	40
	Slate-coloured sand	5 ...	45
	Bluish-green sand with shells and water	10 ...	55
	Slate-coloured clay	5 ...	60
	Slate-coloured clay with sand	4 ...	64
	Blue clay	6 ...	70
	Dark blue clay	10 ...	80
	Dark blue clay with sand	2 ...	82
	Bluish sand with water	10 ...	92
	Clay with sand	35 ...	127
	Bluish sand with water	3 ...	130
	Black sand with water	2 ...	132
	Green sand with water	5 ...	137
	Blue clay with sand	10 ...	147
	Light bluish clay with sand	23 ...	170
	Light blue clay with little sand	5 ...	175
	Blue clay	2½ ...	177½
[Bagshot Sands?]	Dark blue sand	2½ ...	180
	Dark blue coarse sand with water	2 ...	182
	Coarse white sand with water	38 ...	220

SOUTHAMPTON.—Docks.

Mr. T. W. Shore, in *Rep. Brit. Assoc.* for 1883, pp. 152, 153.

Shaft 63 feet, 9 inch bore to bottom.

	Thickness. Feet.	Depth. Feet.
From surface? - - - - -	30 ...	30
Blue clay - - - - -	10 ...	40
Sand - - - - -	10 ...	50
? - - - - -	58 ...	108
Very hard blue clay - - - - -	27 ...	135
Dark green sand - - - - -	5 ...	140
Fine whitish running sand, with water - - - - -	16 ...	156
A mass of stone - - - - -	28 ...	184
? - - - - -		
Light brownish clay, with sand, with occasional frag- ments of stone- - - - -	11 ...	195
Ditto, bluish - - - - -		
Hard blue clay, with very slight mixture of sand - - - - -	15 ...	215
Ditto, with broken shells - - - - -	1 ...	216
Hard lead-coloured clay, with very slight mixture of sand - - - - -	34 ...	250
Hard blue clay, with a slight mixture of sand - - - - -	5 ...	255
Hard bluish clay, without sand - - - - -	5 ...	260
Hard lead-coloured clay, with pyrites - - - - -	5 ...	265
Very hard, dense, lead-coloured clay - - - - -	5 ...	270
Hard clay, with pyrites - - - - -	2 ...	272
Hard dense clay, with nodular fragments - - - - -	4 ...	276
Hard clay - - - - -	24 ...	300
Layer of stone - - - - -	$\frac{1}{2}$...	300 $\frac{1}{2}$
Dense hard clay - - - - -	12 $\frac{1}{2}$...	313
Fine dense sand - - - - -	3 ...	316
Black rolled pebbles - - - - -	2 ...	318
Fine hard sand, with slight mixture of clay - - - - -	3 ...	321

SOUTHAMPTON.—Docks—*cont.*

	Thickness. Feet.	Depth. Feet.
Rolled black pebbles - - - - -	1 ...	322
Hard light-coloured sand - - - - -	9 ...	331
Sandy clay - - - - -	7 ...	338
Hard sand, with clay - - - - -	3 ...	341
Clay with sand - - - - -	9 ...	350
Clay - - - - -	3 ...	353
Sandy clay - - - - -	2 ...	355
Clay without sand - - - - -	19 ...	374

SOUTHAMPTON.—Victoria Brewery, Commercial Road (northern side). [w.]

About 27 feet above Ordnance datum at the entrance.

Two old wells, communicated by Mr. Barlow.

A large one in the field westward of the northern end of the brewery.
1871.

Shaft 28 feet, bored to 113.

Clay, with occasional sand. Four inches of hard smut at 90 feet.

A smaller well southward, close to the western side of the brewery

Shaft 42 feet, bore-hole 73 more.

Water-level 14 feet down.

White sand touched, whence water rose quickly.

Trial-boring, made and communicated by Messrs. Legrand and Sutcliff.
(Notes in these brackets from specimens.) 1896.

Water rose 8 feet above the ground.

Mr. Barlow reports that a supply at the rate of 12 gallons a minute was got at 287 feet.

	Feet.	Feet.
Made ground (stony soil) - - - - -	6 ...	6
Red mottled sandy clay (brown and green grey) - - - - -	5 ...	11
Green mottled sandy clay (grey) - - - - -	4 ...	15
Sandy clay (grey) - - - - -	15 ...	30
Sand and clay (grey) - - - - -	60 ...	90
Clay with little sand (grey) - - - - -	11 ...	101
Live sand with clay (fine grey sand) - - - - -	11½ ...	112½
Clay and sand (grey sandy clay) - - - - -	21½ ...	134
Clay and stones (pyrites and small nodules) - - - - -	1 ...	135
Clay and sand (greenish-grey clayey sand and sandy clay) - - - - -	7 ...	142
Very fine sand and clay (dark brownish-grey clayey sand, damp) - - - - -	7 ...	149
Coarse sand (grey sharp sand, with lumps of clay and bits of lignite) - - - - -	8 ...	157
Brown clay, little sand and peat (sand of the colour of coffee-grounds when damp) - - - - -	17 ...	174
Brown clay and black pebbles (flint) - - - - -	½ ...	174½
Greenish clay and sand - - - - -	18½ ...	193
Greenish clay and shells - - - - -	3 ...	196
Greenish clay and sand - - - - -	15 ...	211
Greenish clay (black flint) pebbles and shells - - - - -	2 ...	213
Greenish sand and clay (in the top 2 feet, a bit of fossil wood, and some small patches of green earth. The green colour is throughout not from grains of glauconite) - - - - -	17 ...	230
Brown and green clay, sand and shells - - - - -	2 ...	232
Brown clay and sand, with 4 inches of claystone at top and 2 at base - - - - -	5½ ...	237½
Brown clay, sand and shells - - - - -	12½ ...	250
Rock - - - - -	2 ...	252
Clay, sand and shells - - - - -	11 ...	263
Rock - - - - -	1½ ...	264½
Clay, sand and shells, with 4 inches of rock 10 feet down - - - - -	15½ ...	280
Clay and sand - - - - -	6 ...	286
Greenish sand and pebbles - - - - -	9 ...	295

SOUTHAMPTON.—Messrs. Driver and Co., northern end of Three Fields Lane. 1900.

Bored and communicated by Messrs. Legrand and Sutcliff.

Water level 4 feet below surface.

		Thickness. Feet.	Depth. Feet.
	Dug well -	-	22
[Bracklesham Beds.]	Sand, clay and mundic	73	95
	Clayey sand -	3	98
	Sandy clay -	10	108
	Sandy clay and stones -	14	122
	Hard clay and stones -	18	140
	Very hard clay	13	153
	Green sandy clay-	1½	154½
	Hard clay -	1½	156
[Bagshot Sand ?]	Grey sand (blowing) -	2½	158½
	Sand and loam	7½	166
	Loamy sandstone and clay -	17	183
	Hard clay -	7	190
	Clay and pebbles (rotten)	3	193
[London Clay ?]	Blowing sand	3	196
	Sand and pebbles	1	197
	Sand (blowing)	20	217
	Loamy sand -	6	223
	Sandy clay	10	233

SOUTHAMPTON.—Messrs. Forders' Brewery, between High Street and French Street, 1895. [w.]

Made and communicated by Messrs. Isler and Co.

Supply 1,000 gallons an hour. Water overflows.

		Thickness. Feet.	Depth. Feet.
Well (the rest bored)		—	40
[River] gravel	-	2	42
[Bracklesham Beds. 131 feet.]	Green sand	16	58
	Green sand and marl -	3	61
	Green sand -	7	68
	Green sand and clay -	5	73
	Green sand and shells	6	79
	Clay and sand -	6	85
	Clay	9	94
Brown [Bagshot] sands	Brown clay -	79	173
	-	9	182

SOUTHAMPTON.—Chapel. 1885. Trial-boring. From specimens taken at intervals of a foot, shown by Mr. Bennett, Borough Surveyor.

Made ground and rubbish found at first.

Gravel, from 12 to 16 feet.

Sand and gravel to 17 feet.

[Bracklesham Beds.]	Loam, with sand and small stones, to 18 feet.
	Brown loam to 20 feet.
	Grey loam to 42 feet, more sandy in places (26, 28, 36, 40, and 42 feet).

SOUTHAMPTON.—Northam Lead Works (Messrs. James and Rosewall), at the corner of Clarence Street and George Street, northward of the Northam Board School, 1896. [w]

About 10 or 12 feet above Ordnance datum.

Made and communicated by Messrs. Legrand and Sutcliff, and from a few specimens, the account of which differed somewhat.

Water rose to $7\frac{1}{2}$ feet above the ground.

		Thickness. Feet.	Depth. Feet.
[River's Drift]	Dug well (brick earth and gravel. Mr. James says clay for about 10 feet.)	—	17
	Gravel, said to have been put in the Well	3	20
	Sandy gravel. Specimen shows a mixture of grey sand and gravel	$2\frac{1}{2}$	$22\frac{1}{2}$
[Bracklesham Beds.]	Loamy sand (specimen grey loam)	1	$23\frac{1}{2}$
	Grey sand (? clayey)	$2\frac{1}{2}$	26
[Bagshot Sand.]	Live grey sand (specimen sharp sand)	$3\frac{1}{4}$	60
	Live grey sand and pebbles (specimen sharp sand, with black flint pebbles)	$6\frac{1}{2}$	$66\frac{1}{2}$
[Bagshot Sand, or London Clay.]	Live grey sand (specimen, apparently from this, grey loam)	$27\frac{1}{2}$	94
[London Clay. All the specimens dried hard.]	Dark grey loamy sand (specimen loam)	13	107
	Sandy clay (specimen brownish-grey)	4	111
	Hard blue sandy clay	5	116
	Hard sandy clay	13	129
	Sandy clay and shells (specimens brownish-grey, shells broken)	5	134
	Sandy clay	22	156
	Sundstone rock (specimen septarian limestone)	1	157
	Sandy clay (specimen brownish-grey)	$8\frac{1}{2}$	$165\frac{1}{2}$
	Rock (specimen septarian limestone)	3	$168\frac{1}{2}$
	Sandy clay	$20\frac{1}{2}$	189
	Stone (septaria)	$1\frac{1}{2}$	$190\frac{1}{2}$
	Sandy clay	$15\frac{1}{2}$	206

SOUTHAMPTON.—Mr. Hayward's Nursery, Shirley Road, eastern side, northward of the Board School, 1895? [w]

Information from Mr. H. G. Vacher.

No spring found, only soakage water, easily pumped dry in summer.

		Thickness. Feet.	Depth. Feet.
Gravel		about 6	6
[Bracklesham Beds.]	Blackish Sandy Clay	24	30

WELLOW.—Embley Park.

Made and communicated by Mr. J. Grace.

Water, at 180 feet, rose 8 feet above the ground.

	Thickness. Feet.	Depth. Feet.
Soil	2	—
Gravel	6	—
[Bagshot?] Loamy Sand	14	22
[London Clay]	158	180
{ London Clay		
{ Pebbles (? Basement-bed)	1	181
[? Reading Beds.] Sand with water	46	227

If the above interpretation of the beds is right, the London clay is thinner than one would have expected.

Trial-borings.

BADNAM CREEK.—One and a quarter miles from Netley, in the course of the proposed Netley and Fareham Line.

Soil		Feet.
[Alluvium]	Dark peaty clay	$\frac{1}{2}$
	Soft bluish sand	3
	Soft light-blue clay, with yellowish streaks and a mixture of sand	3
	Gravel	$\frac{1}{2}$
[Bracklesham Beds.]	Fine soft wet sand	$5\frac{1}{2}$
	Soft yellowish sandy clay	3
	Stiff dark-blue clay	2
	Stiff blue clay of a lighter tint	3
	Bluish sandy clay	7
	Strong blue clay	4
		37

BURSLEDON.—Four Trial-borings along the centre-line of the proposed Netley and Fareham Railway.

Communicated by Mr. J. Drage (L. and S. W. Co.'s District Engineer), 1886.

A. On the mud-land on the right side of the Hamble River, a little eastward of the cross-roads (high-road).

	Thickness. Feet.	Depth. Feet.
[Alluvium.] Soft dark alluvial soil	4 ...	4
Dark gravel, dirty	1 ...	5
[London Clay.]	Soft yellow clay	7 ... 12
	Dark blue clay	8 ... 20
	Hard dark blue clay	6 ... 26
	Light - coloured compact sandstone [?septaria]	1 ... 27

B. At the right edge of the Hamble River, a little E. of S. of the house named Maidenstone Heath.

	Thickness. Feet.	Depth. Feet.
[Alluvium.] Soft dark alluvial soil	4 ...	4
[London Clay.]	Soft yellow clay	7 ... 11
	Dark blue clay	10 ... 21
	Hard dark blue clay	20 ... 41

C. Eastward of the middle of the river, S.E. of Maidenstone Heath.

	Thickness. Feet.	Depth. Feet.
[Alluvium.]	Soft dark alluvial soil	11 ... 11
	Soft yellow clay	6 ... 17
Gravel mixed with clay		5 ... 22
[London Clay.]	Dark blue clay	6 ... 28
	Hard dark blue clay	4 ... 32

D. Near edge of mud-land on the left side of the River Hamble eastward of C. (about a quarter of a mile W. of N. from Lower Swanwick).

	Thickness. Feet.	Depth. Feet.
[Alluvium] Mud	3 ...	3
[London clay]	Light-yellow clay	5 ... 8
	Dark blue clay	14 ... 22
	Hard dark-blue clay	13 ... 35

In a geological section across the River Hamble, on the tracing from which the above were taken, Mr. Drage regards all the yellow clay as a continuous mass, above the gravel of Boring C. I am inclined to think, however, that except in that boring, it is merely the discoloured top of the London clay.—[W.W.]

HYTHE.—Eleven Trial-borings on the mud in front of Winterton Hall, 1885? Communicated by Mr. G. F. L. Giles.

Alluvium	{	Mud, thickening away from the shore; a foot or 2 feet in three close to the shore, 5 to 25 feet in the rest, the furthest being about two-thirds of the way from high to low water mark.
		Peat, in three of the four outermost only (not the outermost, in which the mud rests on the gravel), 2 feet or 4 feet (in two).
		Clay, in two of the four outermost only; 2 or 4 feet, in the former case doubtful and not pierced.

Gravel, in all but one (that last alluded to), 2 to 10 feet, not always pierced (not to S.E., where thickest).

Clay, in 5 on N.W., 4 to 13 feet.

Another boring on edge of marsh, near well.

SOUTHAMPTON—Trial-boring on the right (western) bank of the Itchen, close to the Floating Bridge. (Dock-side) 1900?

Made and communicated by MESSRS. TILLEY.

		Thickness. Feet.	Depth. Feet.
Trench already dug	- - - - -	-	9
	{ Soft mud	4	13
	{ Blue clay	2	15
[Alluvium,	{ Sandy clay	1	16
15 feet.]	{ Clay and pebbles	2	18
	{ Peat	3	21
	{ Sandy clay	2	23
	{ Clay and shells	1	24
[River Gravel,	{ Fine ballast	1	25
5 feet.]	{ Coarse ballast	4	29
[? Bracklesham Beds.]	{ Sandy blue clay	3	32

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